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VOLUME 17, NO. 7
JULY 1985

THE SHOCK AND VIBRATION DIGEST

A PUBLICATION OF
THE SHOCK AND VIBRATION
INFORMATION CENTER
NAVAL RESEARCH LABORATORY
WASHINGTON, D.C.

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THE SHOCK AND VIBRATION DIGEST

Volume 17, No. 7
July 1985

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This periodical is for sale on subscription at an annual rate of $200.00. For foreign subscribers, there is an additional 25 percent charge for overseas delivery on both regular subscriptions and back issues. Subscriptions are accepted for the calendar year, beginning with the January issue. Back issues are available -- Volumes 11 through 16 -- for $40.00. Orders may be forwarded at any time to SVIC, Code 5804, Naval Research Laboratory, Washington, D.C. 20375-5000. The Secretary of the Navy has determined that this publication is necessary in the transaction of business required by law of the Department of the Navy. Funds for printing of this publication have been approved by the Navy Publications and Printing Policy Committee.

A publication of

THE SHOCK AND VIBRATION
INFORMATION CENTER

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SVIC NOTES

Tell the Story

This was written at the time we were planning the program for the 56th Shock and Vibration Symposium so I chose the topic of selecting papers for technical meetings for this month's "SVIC Notes."

While the paper selection process differs between the various organizations that sponsor technical meetings, I believe it can still be divided into two distinct phases. The initial stage of the paper selection process is to obtain a preliminary assessment of the technical merit of the author's work. The technical content of the paper is evaluated during the final stage of the paper selection process, and this is done by subjecting the paper to a peer review before publication. I will concentrate on the initial stage of the paper selection process because the use and the importance of the peer review in selecting papers for presentation or for publication is well known.

In the initial stage of selecting a paper, its preliminary technical merit is often based on the quality of a one or two page summary of the author's work which must tell the author's story in an abbreviated fashion. To be specific, the summary should not only tell what was done, it should describe the problem that was solved and the unique features that set the solution of the problem apart from just another routine engineering effort. If new methods were developed to solve the problem, then their development should be briefly described, and the shortcomings of the existing methods for solving the same problem should be discussed.

This initial stage of the paper selection process may not seem to be as important to some as the final stage, where the paper's technical content is evaluated; but it should not be taken lightly. This stage of the paper selection process may be more important than many realize because quite often the decisions, whether to allow a paper to be presented, or whether to review the complete paper for publication, may be made at this stage of the paper selection process, and those decisions will be based on the quality of the author's summary.

Undoubtedly, a few worthwhile papers have been rejected at the initial paper selection stage because the authors summaries did not tell the story; this was one of the most frequent reasons for recommending the rejection of proposed papers for this year's and for previous Shock and Vibration Symposia. The rejection of otherwise worthwhile papers is unfortunate because useful information, although it exists, is effectively lost since it is not in a form where it may be readily retrieved. If someone else needs this same information in the future, he or she will have to duplicate the original development effort to get it, and this will be costly.

RHV

EDITORS RATTLE SPACE

THE LITERATURE REVIEW

One of the major sections of the **DIGEST** is the Literature Review, the purpose of which is to provide subjective assessment of the literature published on shock and vibration over a three year period. The articles are intended to present summaries of the major developments in small well-defined areas and to eliminate published material with little utility. The first time a literature review is published in a given area a short tutorial is included along with a sketch of the classical literature published to date. The field of shock and vibration has been divided into about 150 subject areas to accomplish this program.

During the past ten years this program has had mixed success. Many excellent articles have been published, but some topic areas are not even touched -- particularly those involving experimental work. In many cases it is difficult to obtain reviewers. Authors most frequently survey the entire literature in an area rather than prepare a critical review. This usually causes much extra unrequired effort. Another pitfall involves the definition of the topic area. Large topic areas necessitate lengthy articles and a discouraging amount of preparation time. Occasionally the author never finishes the review. Typically a topic area should not encompass the breadth of the authors' technical expertise but rather a small well-defined part of it.

At present we are examining the literature review program to determine what can be done to make it more effective. New reviewers are being solicited, old reviewers are being encouraged, and topic areas are being evaluated.

If you are interested in joining the literature review program of the **DIGEST**, please send a short (50 word) description of your potential topic area or write for the preparation guidelines. We are particularly interested in obtaining reviews from those who conduct tests on equipment or who have developed testing techniques. Each reviewer receives a free three (3) year subscription to the **DIGEST** for his or her efforts.

R.L.E.

ASEISMIC BASE ISOLATION

J.M. Kelly*

Abstract. This review covers developments in research and implementation in aseismic base isolation since May, 1981. The considerable increase in research has been both theoretical and experimental and has been conducted at an increasing number of centers. There has been a concomitant increase in the implementation of technology. Several new buildings have utilized various forms of base isolation system. This review describes these recent developments. It is not concerned with patents or other proprietary arrangements for specific systems; some of the systems described in this review may be subject to such restrictions.

Aseismic base isolation is a relatively old concept that has only recently become a practical possibility as a result of developments in building technology. As an approach to earthquake protection it is in complete contrast to standard aseismic design. Conventional methods seek to protect buildings against earthquake hazard by increasing their structural strength and their capacity to dissipate energy. Seismic regulations require that the vibrational energy due to earthquake loading be absorbed by inelastic action of a structural system. Consequently, a structure, particularly at beam-column connections, must be designed with the requisite ductility. Inelastic behavior has the effect of increasing both the natural period and damping of a structure, thereby limiting its response. However, inelastic behavior inevitably involves damage to a structural system and also to nonstructural components and equipment.

It is the horizontal components of earthquake ground motion, amplified by the dynamic response of a structure, that do the most damage to a building and its contents. In the base isolation approach, the building floats on a system of foundation bearings that act to uncouple the building from horizontal ground accelerations. The building is then isolated at the base from the damaging components of the earthquake; not only is the structural system protected but occupants and contents are protected as well.

Since the previous review of seismic isolation, which covered research and implementation to 1980, there has been a dramatic increase in interest in this area. The rate of publication of research papers both on theoretical aspects of the subject and on experimental results has risen sharply. Since the last review buildings that were then under construction have been completed, several new building projects have been initiated, and others are contemplated. Buildings have been constructed on base isolation systems in France and New Zealand; construction has begun on a building in California that will be the first base-isolated building in the United States. There are definite plans to start construction in 1985 of a second base-isolated building in California. The potential application of base isolation is being studied with regard to liquid-metal fast-breeder reactors in the United States and conventional reactors in Japan.

Research on base isolation has spread to centers in the United States and other countries; many new forms of isolation system have been studied. Most practicable isolation systems are based on laminated rubber bearings with steel reinforcing plates; additional elements provide other response characteristics. The behavior of rubber bearings is now better understood, and much work has been done to improve elastomers. Other systems have been developed that incorporate other types of spring elements; some systems involve slid-

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ing elements. They are described in this review.

A major impediment to the use of base isolation technology prior to 1981 was a lack of explicit reference to the method in building codes. This has been somewhat alleviated by development of code specifications. Another deterrent is specifying design spectra at the low frequencies of base-isolated systems; in particular, there is a lack of confidence in predicting maximum displacement demands at the isolation system. A code for conventional design -- the UBC, for example -- is based on an equivalent lateral force of 12% to 18% of building weight. Base isolation requires a maximum credible earthquake of a very high magnitude. However, no records of ground accelerations and ground displacements exist in the near field of a very large earthquake. The designer is confronted by uncertainties that would not arise if a conventional design were used.

RUBBER BEARING ISOLATION SYSTEMS

Rubber bearings are the simplest isolators and are relatively easy to manufacture. Experience with bridge bearings, which are similar to rubber bearings, has provided confidence in their longevity and reliability. The bearings used in seismic isolation systems are made by bonding thin sheets of natural or artificial rubber (usually neoprene) to thin reinforcing steel plates. The bearings have the mechanical characteristic of flexibility in the horizontal direction and stiffness in the vertical direction. They act under seismic loading to isolate a building or structure from the horizontal components of ground motion. The vertical components of earthquake ground motion are transmitted unchanged into a structure; bearings will provide isolation against higher frequencies of ground motion such as are caused by traffic and underground transit systems. The bearings are suitable for buildings that are rigid and low-rise, up to about seven stories; uplift on the bearings will not occur and wind loading will be relatively unimportant.

Since 1981 research has led to a better understanding of bearing function and improvements in the rubber compounds. Rubber compounds with properties suitable for use in seismic isolation systems have been developed. Theoretical work on bearing development has been published in the Proceedings of a Conference devoted to the topic. The Proceedings contains a review of the basic principles of rubber bearing isolation [1], details of bearing stability [2] and design [3], and a review of rubber properties important in the performance of isolation bearings [4]. In practical design of isolation systems with rubber bearings the bearings are customarily dowelled to the foundation to prevent the development of tension in the rubber. This leads to the possibility of a roll-off at the top and bottom surfaces of a bearing when it is loaded in shear. Such roll-off has the effect of reducing the stability of the bearing; an analysis of this phenomenon has been reported [5]. In most analyses of bearing stability, the reinforcing plates are considered rigid. However, it is clear from experimental work that warping of these plates occurs; an analysis of the influence of plate deformation on the stability of the bearings is available [6].

It is usually adequate to model a building isolated on rubber bearings by a linear viscously damped model; simple solutions result. When the fixed-base frequency of a superstructure is much higher than that of the isolation system, the first mode is a predominantly rigid body mode; as a consequence the higher modes are orthogonal to the dynamic input and are thus not excited. This is a particularly attractive feature of a rubber bearing system. If other elements are added for the purpose of increasing damping or controlling displacement, a simple solution is no longer possible; higher mode response can be generated.

Unlike conventional buildings base-isolated buildings tend to have coincident periods in both lateral directions and in torsion. They can also have coincident periods in pure vertical response and rocking response. The possibility of coupling in these modes thus exists. The influence of rubber damping on the seismic response of torsional-lateral coupling has been treated [7]. The response of systems with coupling in the vertical and rocking modes has been described [8]. The results of these

studies indicate that, with the degree of damping possible in rubber bearings, the influence of such coupling is not likely to be important. However, it is worth noting that many modern buildings have, for architectural reasons, unsymmetrical structural configurations; such buildings can have a very unbalanced response under seismic loading [9]. The use of base isolation for this type of building would be beneficial in that the bearings could be located to balance the center of mass and the center of stiffness. In addition, the response of the superstructure would be mainly rigid motion and would thus cancel negative structural effects of the configuration.

Experimental work on the response of rubber-isolated systems is continuing at several centers. Shake table studies at the Earthquake Simulator Laboratory of the Earthquake Engineering Research Center of the University of California at Berkeley have included an isolation system using rubber but with a fail-safe system [10, 11]. This system was also tested by an explosively generated simulated earthquake [12]. Shake table tests also included an isolation system for a large power plant component [13] and the effects of various isolation systems --all of which incorporated damping devices -- on the response of light secondary equipment [14, 15]. The results show that, if rubber bearings are used with no additional add-on elements, the orthogonality of higher modes to the input greatly reduces the response of the equipment as compared with conventional construction. The degree of protection afforded the light equipment is superior to that provided for the building itself. However, when other elements are added to provide additional damping, they inevitably produce high-frequency response and accelerations in the equipment. Many of these damping elements have the desirable effect of controlling displacements at the isolation system with a relatively small increase in accelerations throughout the structure but produce substantial increases in acceleration of equipment.

Shake table tests of an isolation system incorporating rubber bearings denoted by the code name GAPEC were carried out on the shake table at the John A. Blume Earthquake Engineering Center at Stanford University [16]. GAPEC isolators are conventional laminated natural rubber bearings; they were used in a small school in France constructed in 1978 [17]. These isolators have also been installed under circuit breakers in an electric power plant in California [18]. Electrical facilities proved extremely vulnerable to earthquake attack in the 1971 San Fernando Valley earthquake. In fact, electrical equipment in switchyards was identified in the aftermath of that earthquake as the most vulnerable component.

GAPEC isolators are now being used in a three-story building in Toulon, France, for the French Navy [19]. The building is to be used to store radioactive waste. The isolation system uses 52 rubber bearings. The building is reinforced concrete throughout the external shear walls and an internal frame; it is 24m x 13m in plane and about 15m high. The unisolated period of the structure was 0.30 sec; under the design earthquake that had a peak of 0.3g the maximum response acceleration was 0.61g. When isolated the period was extended to 0.73 sec and the calculated acceleration was 0.33g. The vertical stiffness of the isolators is 360 times the horizontal stiffness.

Interest in isolation appears to be developing in Japan. At least three Japanese construction companies have carried out experimental tests of isolation system with natural rubber bearings; research on isolation is also being carried out at the University of Tokyo [20]. Laminated rubber bearings and frictional slip plates are used to enhance the system damping. Static tests of the system have been carried out [20].

Static and dynamic tests of an isolation system that uses laminated rubber bearings and steel bars to enhance damping have been carried out at the Technical Research Institute of Obayashi-Gumi Ltd. [21]. Dynamic tests were carried out with a large model (10 tons) on a 3m x 4m shake table. The Takenaka Construction Co. built a large model of a coal silo and mounted it on rubber bearings. This system also has a damping system that uses a thixotropic material between flat plates.

The model was tested by pull-back and logarithmic decrement tests [22].

The first base-isolated building in the United States will be the Foothill Communities Law and Justice Center now under construction in the municipality of Cucamonga in San Bernardino County. It is 12m x 33.5m in plan and four stories high with a full basement and sub-basement for the isolation system. The building will sit on 98 isolators that are multilayer natural rubber bearings reinforced with steel plates. The superstructure of the building is a structural steel frame stiffened by braced frames in some bays.

The site of the building is 20 kilometers from the San Andreas fault and the County, which has the most thorough earthquake preparedness program in the U.S., asked that it be designed for a maximum credible earthquake for that site. The design spectrum provided by geotechnical consultants was predicated on an 8.33 Richter magnitude earthquake at the fault; it was a constant velocity spectrum of 1.27m/sec over a range 0.8 sec to 4.0 secs period for 5% damping. The design selected for the isolation system accounted for possible torsion of the building and the fact that damping in the isolation system will be much higher than the 5% assumed in the design spectrum. The result was a maximum displacement demand of 380mm in the isolators at the corners of the building. Full-scale sample bearings have been built; tests have verified that 380mm relative horizontal displacement is within the capacity of the bearings [23].

The rubber for the isolators is a highly filled natural rubber with mechanical properties that make it ideal for a base-isolation system [24]. Its shear stiffness is high for small strains but decreases by a factor of about four or five as the strain increases, attaining a minimum value at a shear strain of 50%. For strains greater than 100% the stiffness begins to increase again. Thus, for small loading caused by wind or low-intensity seismic loading the system has high stiffness and short period; as load intensity increases, stiffness drops. For very high load, say above a maximum credible earthquake, the stiffness increases again, providing a fail-safe action. Damping follows the same pattern but less dramatically, decreasing from an initial value of 20% to a minimum of 10% and then increasing again. In the design of the system the minimum values of stiffness and damping are assumed; response is taken to be linear. The high initial stiffness is invoked only for wind load design and the large strain response only for fail-safe action. The characteristics of the bearings make the structure distinctly different from conventionally designed buildings as well as from the few base-isolated buildings that now exist in other countries.

LEAD PLUG BEARING SYSTEM

A program for development of special components for earthquake-resistant building design has been carried out in New Zealand for many years. One of the results of this program is the lead plug isolator, in which a cylindrical plug of lead is inserted in a hole in the center of a laminated rubber bearing. This system was developed in the late 1970s; the intrinsic damping in rubber compounds available in New Zealand at that time was inadequate to control displacements at the isolation system. The lead plug substantially increases damping from the approximately 3% available in the rubber to about 10-15% and also provides resistance to wind loading. The system was originally proposed and used in a building in New Zealand completed in 1982 [25]. The design details of this building have been described [26]. Since this system was first proposed, extensive static testing has been carried out [27-29]. A review of the use of this system in New Zealand is available [30].

Theoretical analyses of the response of buildings using the lead plug system have been carried out [31-33]. Shake table tests of a model structure on lead plug bearings have also been carried out [34]. The theoretical analysis and the experimental results show that the lead plugs generally reduce system displacement but increase higher mode response. Evidence is that damping in the bearings is dependent on the degree of confining pressure on the bearing. Problems have occurred with the lead working into the rubber and with the lead plug fracturing, thereby reducing its

effectiveness. However, development on the system continues [29], and tests have been carried out on materials that could substitute for lead but produce the same degree of damping. Sand has been used with successful results [35]. Plans [36] are to use the lead plug system in California in a complex of buildings to be built for the Tandem Corporation. It will be located within 11 kilometers of the San Andreas fault close to San Jose, California.

SLEEVED-PILE SYSTEMS

Piles have been used for many years to support the weight of structures. They are typically used when soil conditions are such that footings or slab-type foundations are too expensive. All other types of base isolation system -- roller systems, sliding systems, and rubber pads -- require the more common concrete footing or slab foundation. Therefore, when circumstances dictate the use of piles as the most economical method of support, the sleeved-pile design is sometimes the best solution to the problems of structural support and isolation from ground excitations.

A sleeved pile is a pile within a sleeve. It can be an end bearing or friction pile; the significant difference between sleeved piles and conventional piles is the free length of the sleeved pile. A length of pile that is unrestrained by the surrounding soil allows long isolation periods, thereby effectively isolating a structure from most ground excitations.

The sleeved-pile concept can be thought of as providing most of the benefits of the soft first story design concept without that system's problem of collapse under excessive first story lateral deflections. If, for some reason, a structure does exceed lateral displacements in a design, lateral deflections of the sleeved pile are restricted by the sleeve itself. This restriction provides a fail-safe characteristic for a system.

Theoretical work has been carried out at the Massachusetts Institute of Technology [37, 38]. A simple design procedure for sleeved piles has been developed and the feasibility of using sleeved piles as an isolation system has been investigated. The use of dampers to limit base displacements was also suggested.

A 12-story office building called Union House [39] has been constructed in Auckland, New Zealand; sleeved piles in conjunction with energy dissipators were used as an earthquake isolation system. The piles were designed as pinned-pinned and are about 12m long and 900mm in diameter. The sleeves can accommodate displacements of 150mm; this corresponds to a maximum credible earthquake. The design earthquake displacement is 60mm. Without dissipators the estimated extreme earthquake base displacement is 280mm. The isolated structure has a period of about 2 secs when the dissipators are included and a fundamental period of about 4 secs on the piles alone. For a design earthquake, interstory displacements are below 5mm and below 10mm for a maximum credible earthquake; these displacements imply that the structure behaves essentially as a rigid body.

SLIDING SYSTEMS

This section is concerned with systems in which the isolation mechanism is entirely sliding friction. This contrasts with systems in which rubber bearings are used in conjunction with frictional sliders to enhance damping. Sliding systems are by far the simplest isolation system. The first suggested use of isolation for earthquake protection was of this kind. An engineering commission was established by the Italian government in 1908 after the Messina-Reggio earthquake of that year in which 160,000 people were killed. The Commission favored two approaches to earthquake protection: to isolate a building by using a sand layer under the foundation and to connect the building to a rigid foundation and impose height limitations [40]. The second proposal was adopted.

Sliding systems have been the subject of much theoretical analysis. The response of a rigid mass on a sliding system to earthquake input has been treated [41, 42]. The seismic response of structures on a sliding foundation has also been considered

[43-46]. The same problem for periodic input motion has been treated [47-49].

Very little experimental work has been done on sliding systems; as far as is known no large-scale shaking table tests have been carried out. However, tests have been described [50-52] of the performance of half-size single-story brick buildings that were subjected to shock loading using a railway wagon impact facility. Several types of model building were tested, including both isolated and non-isolated. It was concluded that buildings with a sliding joint performed better than a conventional building and that the method was economical compared to that used for other structures.

The idea of a sliding joint as an isolation system is attractive for low-cost housing because it requires no more complicated technology or skilled labor than a conventional building. For this reason, it has been developed for housing in China [53]. After the Tang Shan earthquake of 1976, masonry block buildings in which the reinforcement was not carried through to the foundation performed better than buildings in which it was. In one structure that performed well during the earthquake a horizontal crack was observed at the root of the wall; a residual displacement of about 6cm occurred. As a result of these observations the approach adopted in China is a separation layer under the floor beams above a wall foundation [54]. A thin layer of specially screened sand is laid on the sliding surface; the building constructed on the sand. Low-rise concrete block or masonry buildings are very stiff and heavy structures; they are thus susceptible to earthquake damage and can be dangerous. The sliding layer allows a degree of flexibility that reduces seismic risk. Four demonstration buildings have been built in China using this technique. Three are one-story brick houses; the fourth is a four-story brick dormitory in Beijing for the Strong Motion Observatory Center.

A small shake table was used to verify the response of a small-scale building model constructed of miniaturized bricks on a sliding system. The sliding joint was activated when the table accelerated to 0.2g; the superstructure slid without collapse [54].

One single-story building was tested by subjecting it to explosively generated strong ground motion. The house was deliberately built with very poor quality materials but survived the shock by sliding instead of collapsing [54].

ROLLER BEARING SYSTEMS

Roller bearings have been proposed for isolation systems for years, and many roller systems have been patented. Most of the systems that have been tested have been rollers. But to accommodate the two-directional ground motion of an earthquake it is essential in a practical system to use spherical bearings -- which means very high contact stresses -- or two orthogonal layers of rollers -- which increases cost and decreases usable space. Rollers are themselves free of damping; other energy-absorbing mechanisms would thus have to be provided. Reliability and longevity of roller bridge bearings are not satisfactory, and they have been more or less entirely replaced by rubber bearings. It is unlikely that roller bearings or spherical bearings for buildings would perform much better. Nevertheless, they continue to be proposed, and some testing has taken place. A system of ball bearings and horizontal steel beams, referred to as the TASS system, was tested on a small shake table at the Earthquake Engineering Laboratory of the Taisei Corporation in Japan [55].

A system of this kind has been used in a demonstration building in Sebastopol in the USSR. A dry friction element and rollers in the form of doubly spherical ovoids are used. Displacement of the system forces the building to rise, thus producing a restoring force. The system used in the demonstration building, which is a full-size seven-story building, has a period of three secs and a damping factor of 50%. The system apparently performed to expectation during an earthquake in 1977. Details of the system and the demonstration building are available [56].

MISCELLANEOUS SYSTEMS

Other methods of seismic isolation have been proposed; some have been tested and are applicable to special structures or components. A system combining air-bags and a coulomb friction device that operates only above a pre-set earthquake level has been used to simultaneously isolate a large high-voltage electron microscope from ambient ground vibration and protect it from earthquake attack [57].

Large components in power plants, such as turbine generators, are conventionally provided with isolation systems to prevent the transmission of vibration to other parts of the structure. A standard system includes helical springs and visco-dampers. It has been proposed that this system be used to protect full-size buildings from seismic attack. The springs are not much stiffer in vertical motion than in horizontal, in contrast to laminated rubber bearings that can be several hundred times stiffer vertically than horizontally. A building isolated on springs will be isolated to some extent from vertical components of ground motion, but this is not generally necessary in conventional buildings. In any event the response of the system is such that rocking occurs; as a result large vertical accelerations can develop at the corners of the building even in the presence of a purely horizontal input. Vertical isolation might sometimes be needed, but in these special cases it will probably be more convenient to use a double isolation system than to attempt to cope with the large rocking motions.

In one proposed base isolation [58] helical steel springs are replaced by large unreinforced blocks of rubber. Theoretical analyses of this approach have been given [59-62]. Shake table testing of the concept has been done, but the results have not been published.

Substantial work on optimization of base isolation systems has been carried out. An optimization algorithm has been used to select optimal energy-absorbing devices (modeled as bilinear yielding elements) for use with a rubber bearing system [63-65]. Optimal design of a sliding base isolation system subject to probabilistic input has been studied [66-68].

CODE DEVELOPMENT

Possibly the most serious impediment to the use of isolation systems for seismic protection, at least in the United States, is the fact that such use is not explicitly mentioned in any building code. It is not, however, forbidden by any code; most codes contain a clause to the effect that alternative approaches to seismic protection can be used if their performance can be demonstrated by tests and other documentation. However, a lack of specific recommendations for design and construction of base-isolated buildings in building codes has a deterrent effect on the structural profession.

Codes for bridge bearings have been developed in the United Kingdom and Europe; many of their recommendations can be applied to seismic isolation bearings. An extensive review of bridge bearing codes has been given [69]. Code development relative to vibration isolation for buildings has been carried out in the United Kingdom and has been reviewed [70]. The considerable work done on developing code requirements for seismic isolation of buildings and bridges in New Zealand has been reviewed [71]. Steps have been taken to develop a seismic isolation code for California, but this is still at an early stage [72].

SEISMIC REHABILITATION

Although base isolation has been proposed and used for new construction, the concept could readily be adapted to the rehabilitation of older buildings of architectural and historic merit. The number of unreinforced masonry buildings in California has been estimated at 100,000. Many of these buildings will be demolished rather than strengthened due to the problems associated with conventional procedures that involve adding new structural elements such as shear walls, internal frames, or bracing.

The economic feasibility of base isolation as a method of rehabilitation has been

demonstrated in a specific project. A building in San Francisco was selected for a design study. The exterior of the building, constructed in 1912 as a Masonic Hall, is handsome and the interior elegantly finished. It must be made to conform to the current San Francisco seismic code; under conventional rehabilitation the procedure would be destructive to the interior of the building and extremely costly. A base isolation rehabilitation scheme was developed, drawings were prepared, and the cost to implement the scheme was estimated [73, 74]. The estimate is comparable to that for a conventional rehabilitation. This project indicates that suitable rehabilitation strategies using the concept of base isolation for typical masonry buildings are possible. Given the large number of buildings at hazard in seismically active regions of the United States, it is clear that substantial building replacement cost could be avoided and the safety of older buildings greatly enhanced if this technology is used.

SUGGESTIONS FOR FUTURE RESEARCH

Many practical systems of seismic isolation have been developed in recent years. Interest in the application of this technique for earthquake protection will continue to grow. There continues to be a reluctance on the part of the structural engineering profession to use the concept; this hesitation is due to doubt as to how a building on an isolation system will perform in an earthquake that is substantially larger than one for which the system was designed. The most controversial aspect of seismic isolation is accommodating the large relative displacements that can occur between the building and the foundation. Actual ground displacement time histories have not been measured in large earthquakes; integration of acceleration records to calculate displacements can introduce uncertainties. The actual magnitude of ground displacement is not directly related to displacement at the bearings; velocity of the ground is an important parameter. Thus, an important area of research is to determine the appropriate design spectrum at a particular site in the low frequency range (2.0 to 3.0 sec periods) and in particular to estimate spectral displacements in this frequency range.

Research is also needed to improve internal damping in the elastomers used for isolation bearings. Valuable work has been done along these lines, but additional damping would help by further controlling displacements and reducing the risk of resonance. Add-on damping devices are available, but their use requires complicated mechanical linkages or introduces other practical problems. There is also the question of the long-term stability of the elastomers used for isolation systems. It is essential that stiffness and damping characteristics of bearings remain unchanged over the life of a structure.

Multilayer elastomeric bearings are the best developed and understood components in isolation systems but additional research on their response is needed. Theoretical and experimental analyses of the role of reinforcing plates in bearings is required. In bearing design they are assumed rigid; no design rules are available to determine the required thickness. The question of whether they are necessary or could be replaced by thin flexible but inextensional shims is still open.

As noted, rubber bearings are generally suitable for low rise buildings and have been used only for buildings of four stories and less. The sleeved pile system is suitable for buildings of 12 or more stories. Further research should be directed to development of rubber bearing systems to span this gap. The main technical problem in the use of bearings for buildings in this range is the effect of uplift on a bearing. Theoretical and shake table studies of bearing systems in the presence of uplift should be vigorously pursued.

Research that has been carried out over the past few years and the construction of several new buildings should enable engineers to proceed with confidence that the technical problems of building with isolation can be economically overcome and that the construction process will involve no unexpected problems for contractors. These developments in base isolation represent an important step in the continuing search for increased seismic safety.

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LITERATURE REVIEW: survey and analysis of the Shock and Vibration literature

The monthly Literature Review, a subjective critique and summary of the literature, consists of two to four reviews each month, 3,000 to 4,000 words in length. The purpose of this section is to present a "digest" of literature over a period of three years. Planned by the Technical Editor, this section provides the **DIGEST** reader with up-to-date insights into current technology in more than 150 topic areas. Review articles include technical information from articles, reports, and unpublished proceedings. Each article also contains a minor tutorial of the technical area under discussion, a survey and evaluation of the new literature, and recommendations. Review articles are written by experts in the shock and vibration field.

WIND-EXCITED BEHAVIOUR OF STRUCTURES IV

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Abstract. This article reviews recent literature on wind-excited behavior of structures. Among the phenomena considered are those due to vortex shedding, galloping, flutter, divergence, and turbulence. Theoretical and experimental (model and full-scale) studies are included, as are techniques to alleviate wind-excited behavior.

Earlier review articles [1-3] discussed the technical literature related to the dynamic response and aeroelastic behavior of typical structural forms through 1981. The present paper reviews the literature from late 1981 through 1984. The references cited are tabulated in tables intended to help the specialist find a literature source and particular references that deal with specific topic areas.

THE NATURE OF WIND

Publications that present useful information on the current state of knowledge on the nature of wind (see Table 3) include books [197-199] and reviews [30, 40, 51, 101-103, 109, 139, 159, 165]. Data specific to Hong Kong are also available [204 k, 204 l]. Studies dealing with tornadoes and hurricanes are reported [65, 143, 147, 152, 204]. Wind simulation criteria for wind tunnel tests are discussed [155] and applied in Japanese research [162].

MECHANISMS

Wind-excited responses considered in this article include those due to vortex shedding and subsequent in-line and cross flow bending oscillations; ovalling oscillations; torsional oscillations; galloping oscillations; flutter, divergence (buckling); and turbulence effects. These phenomena have been described [1-3]. Special mechanisms that have been considered include close interference effects [17, 52, 53, 74, 131, 201 c, 201 f, 204 g] and aerodynamics of hanging roofs [34, 69-71].

VORTEX SHEDDING

Basic data on vortex shedding have been given [1-3]; much new information is referenced in the present review. The studies reported consider synchronization, cross flow, and in-line responses. In some cases the additional effects of free-stream turbulence are included.

In-line and cross flow bending oscillations. References for these phenomena are listed in Table 3. The Iwan-Blevins model for predicting wave-vortex excited oscillations of bluff bodies in cross flow using Hopf-bifurcation theory has been studied [4]; good agreement was found with experimental data. In another study [22] an existing mathematical model was adapted to include experimentally observed changes in the near wake and including drag forces. Good agreement was found in the lock-in range.

The Iwan-Blevins coupled wake oscillator model has been applied to marine risers [10]. The structure was represented by a finite element model; the corresponding equations were integrated numerically in time and included turbulence excitation. Another study on marine risers [9] considered steady and unsteady deflections in in-line and cross-flow directions.

Results using the von Karman theoretical formula for mean drag force and the Sallet formula for lift force amplitude, including vortex shedding and forced vibration, have been compared [19]. Other comprehensive studies are available [54, 55]. A two-dimensional mathematical model [54] is

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capable of reproducing two effects -- an increase in span-wise correlation of forces with increasing amplitude and the phenomenon of lock-in. The model was developed within the framework of random vibration theory and uniform flow. It utilizes a nonlinear aerodynamic damping force that co-exists with and is uncorrelated with fluctuating forces arising from vortex shedding. The three-dimensional model considers circular cantilevers of varying diameter and modes of arbitrary shape. This model includes such effects of turbulent shear flow as lateral forces arising from the lateral component of turbulence [55].

Other pertinent studies have had to do with cables [188], chimneys [106], prismatic bodies [49], and angle sections [50]. A two-dimensional angle section [50] was allowed the separate degrees of freedom of plunge and torsion; the former showed lock-in, the latter did not. The motions when combined still tended to occur in either one or the other modes. The plunging resonance was at first due to vortex shedding; this was quickly followed by galloping.

Studies relevant to chimney design for vortex shedding include full-scale and model test data and comparisons with theory and design code requirements [122-128, 130]. Other studies for non-circular sections have been concerned with square and rectangular section cylinders [58, 61, 62, 192, 193]. Table 2 lists references concerned with problems of arrays of cylinders [126, 127, 130, 185, 201 c].

Ovalling oscillations. Three publications [73, 190, 191] from the one research group present experimental evidence [190] suggesting, paradoxically, that vortex shedding can fortuitously aid in the precipitation of ovalling oscillation but is not essential to it. An alternative analytical model [191] based on a quasi-static aeroelastic theory was used to predict ovalling oscillations. The most recent paper [73] summarizes all available experimental evidence; it is concluded that the influence of vortex shedding is uncertain. The paradox remains.

Torsional oscillations. Torsional oscillations as a consequence of vortex shedding have been considered. For square and rectangular model buildings the largest contribution to vortex-excited torque came from rearward faces [61]. Comparisons between model and full-scale buildings are available [63]. Coupled lateral-torsion motions have also been reported [37, 174, 204 o]. Flutter and vortex excitation in smooth and turbulent flows have been studied for a range of rectangular shapes with various depth to height ratios [192]. Different effects of turbulence were observed on high-speed and low-speed torsional flutter and vortex excitation.

GALLOPING OSCILLATIONS

The basic mechanisms underlying galloping are well understood; several relevant review papers are available [1-3, 11, 27, 39, 49]. Full-scale tests have been reported [25], as have comprehensive model tests [26] for six different sections with various corner radii in smooth and turbulent flows. Static and dynamic tests showed good agreement for the plunging mode using measured aerodynamic coefficients. Good agreement was also obtained [32] with theory for the maximum amplitude of a limit-cycle oscillation for a general, arbitrary cross section.

The theory of two-dimensional galloping has been extended to the three-dimensional case of cantilever-supported structures in a uniform stream [49]. In contrast to the results expected the flow velocity for the onset of oscillation was dependent only on body shape. It was impossible to normalize the ensemble of results with dimensionless parameters indicated by theory. Galloping is one of several phenomena considered for bridge sections [80, 81, 134], pylons [81, 129], angle sections [50], and square cylinders in water [193, 201 a].

FLUTTER

Classical flutter can occur when two or more distinct elastic modes couple, even if all individual modal aerodynamic dampings are positive. Various non-aeronautical structural forms --typically slender bridge sections -- have exhibited this phenomenon. A good general review that includes this

topic [11] deals specifically with suspension bridge aeroelasticity. Other papers deal with bridge sections using aerodynamic admittance functions [14, 79]; compare two-dimensional flutter theory with wind tunnel test results [20]; show reasons for and origins of various aeroelastic phenomena using pressure data [80]; and present a wide range of bridge geometries [81] and analyses and test results [97]. A comparison of full-scale data and wind-tunnel data with theory showed that flutter behavior can be predicted reasonably well using aerodynamic thin plate theory [104].

Classical flutter can be cured [134] by openings in lower and upper surfaces of a bridge deck. A review of trends in wind tunnel testing for bridge flutter is available [154]. The flutter of angle sections [50] and suspended roofs [69-71] has been studied.

DIVERGENCE (BUCKLING)

An inflated spherical membrane used for a temporary structure can buckle under a steady wind [100], as can a thin circular cylindrical shell [67, 204 i]. The latter configuration was an antenna shield for a tall mast supported at discrete positions lengthwise. An optimal support location was determined from theoretical and experimental results.

Cooling towers have also been studied for wind-induced buckling [107, 142, 182]. It was demonstrated [107] that a typical reinforced concrete cooling tower would not buckle in the classical sense. Instead, failure was initiated by rapid propagation of cracks in tensile zones followed by temporary stiffening and, finally, by yielding of the reinforcement.

It was shown [107] that buckling loads resulting from linear and geometrically nonlinear pre-buckling analyses are considerably larger than the ultimate load. In addition, results based on a certain form of equivalent axisymmetric pressure are on the unsafe side of corresponding results from an actual wind load. Finally, the crack load, representing a lower bound to the ultimate load, can be estimated by a linear, elastic, non-axisymmetric analysis.

New predictions have been presented [142] for cooling tower buckling and compared with new experimental data. Various analytical techniques were evaluated and extended to circular cylindrical shell buckling due to wind.

TURBULENCE EFFECTS

Of numerous publications on turbulence-induced vibrations [Table 3], the majority have dealt with buildings. The effects of turbulence on other excitation phenomena have also been studied [26, 55, 62, 192].

A study on cables of turbulence-excited deflections and stresses, and hence fatigue — including effects of vortex excitation -- has been reported [5]. An analysis of suspension bridges for buffet uses aerodynamic admittance functions [14]. Time integration has been used with an appropriate algorithm that considers stability, accuracy, and error propagation of the analysis [36].

Comparisons of theory and full-scale data [78] showed over- and under-estimates of response, depending on assumptions, of greater than 20% to 40%. It has been shown that taut strip models on a turbulent boundary layer are capable of simulating full-scale motion [178]. A computation of cross-spectra of bridge response to turbulent wind has been performed [179]. An analysis of turbulence-induced vibrations on the safety of bridges [194] and buildings [6] during construction has been considered. Other relevant studies on bridges are available [18, 33, 201 f, 201 g].

General equations for bi-lateral translation and torsion for high rise buildings have been derived [28]. In three-dimensional analysis the contributions of individual structural members were analyzed [29]. Occupant reactions to gust loads [115, 135] and to typhoon-induced vibrations [65] have been considered.

A design procedure has been developed [105] that provides reasonable estimates (within ± 25%) of cross-wind responses (displacement and acceleration) compared with wind-tunnel measurements at reduced wind

velocities and at structural damping values consistent with modern habitable tall building design. The method uses random vibration theory and mode-generalized cross-wind force spectra. Different building shapes and sizes in both suburban a d city center wind flows were considered.

A similar study [111] for buildings of square cross section produced simplified, closed-form expressions -- based on wind-tunnel measurements -- for auto-and co-spectra of cross-wind force fluctuations for any desired approach flow condition. The expressions provide flexibility in selecting input parameters and w''' be useful in the preliminary design of t. buildings. Response predictions were in excellent agreement with earlier studies [105, 138]. Other relevant studies [106] show peak factors and load factors in excess of those used currently in codes of practice; more rational solutions were offered.

General studies [116, 117] considered the combined effects of resonant and non-resonant inputs. Strength, deflection, occupant comfort, and fatigue have been studied [135]. Existing data on human tolerance of building motion have been published [168]; a simple procedure for the serviceability limit state using random vibration theory was proposed.

A novel method [108] is based on the theory of stochastic differential equations; it is possible to considerably reduce the numerical work compared with methods using power spectral densities. It is claimed that the method gives a deeper insight into the physics of random vibrations.

A closed-form solution for along-wind response estimation [137] begins with a classical formulation. It has been applied to two standard structural models. The remarkable simplicity and high precision of the method are illustrated. It is claimed that parametric studies are easier and criteria more readily formulated for different structural classifications. Relevant papers have been published [93, 94, 136, 173, 177]. Combined effects of turbulent wind and nonlinear hydrodynamic forces due to surge and including coupling effects have also been published [160].

Along-wind motion of a multistory building on compliant soil has been considered in a theoretical study [184]. Results indicated that soil compliancy decreases the response of stiffer moderately tall buildings (up to 10 story) by about 17% but increases response of more flexible very tall buildings (up to 40 story) by about 21%. Some responses were dominated by structural modes higher than the fundamental. Other studies on the influence of the soil are available [48, 195]. Additional studies are concerned with cooling towers [186] and masts and towers [87, 88, 116, 156, 170].

FULL-SCALE DATA

References on full-scale data can be categorized by structural configuration into chimneys [15, 75, 123-126, 128], buildings [7, 8, 60, 63-65, 172, 204], bridges [78, 96, 104, 178], masts and towers [7, 86, 88, 129], cooling towers [56], and transmission lines and cables [25].

The chimney studies included a multi-flue chimney [15] and steel chimneys [75, 123, 125, 126, 128]. Some studies were concerned with vibration alleviation techniques, e.g., helical strakes [125, 128], slats [15], and resilient base damping [75, 204 ι].

A correlation study of 65 full-scale steel chimneys [123] -- varying in height from 23m to 145m --compared reported performance and predictions. A newly developed empirical parameter that gives improved correlation was introduced. This parameter, unlike the Scruton number, is not non-dimensional.

A total of five chimneys and two towers have also been studied [124]. Comparisons of the reinforced concrete structures with a proposed mathematical model showed agreement to within about 5%. Configurations of 5 x 120m high steel chimneys and 3 x 29m steel chimneys with relatively close spacings have also been studied [126]. Structural bracing and dynamic absorbers were considered as remedial measures.

In a study utilizing a proposed code for steel chimneys [128] 12 chimneys were

examined. They varied in height from 40m to 90m.

The buildings studied have been mainly high rise. New data [7] are available for four tall buildings 103m to 170m in height and for 12 buildings [60]. The latter data [60] were correlated with existing data and plotted for 163 buildings. A fundamental frequency (f) vs height (H) relationship -- $f = 46/H$ (for $7<H<200m$) -- was obtained. Some data were compared for measured and predicted responses using two codes.

A 57-story office building has been compared with an aeroelastic wind tunnel model [63]. The results showed a significant torsion effect. Vibration tests and analytical studies on three medium-rise concrete structures [64] have shown the important contributions to building stiffness of certain partitions and shear walls. Active control systems have been studied [172].

Typhoon-induced vibrations in a building and occupant reactions in five buildings have been studied [65]. Typhoon-induced vibrations have been measured [8, 204 s] using a new laser displacement meter.

Predictions of bridge responses compared to measured data are available [78, 96, 104]. The efficacy of taut strip wind tunnel models has been confirmed by full-scale studies [178].

Data for a 250m tower [86] have shown significant increases in damping levels, particularly in the second mode. The increases were produced by a water tank tuned-mass damper and a secondary damper.

TECHNIQUES TO MINIMIZE WIND-EXCITED DYNAMIC RESPONSE

The role of damping, mass, and stiffness in the reduction of wind effects on structures has been studied [47]. The parameters can be considered separately or collectively in alleviation techniques to minimize wind-excited responses [101-103, 109]. A general study is available [35].

Reductions in the periodic nature (and amplitude) of exciting aerodynamic forces on such structures as chimneys can be achieved with helical strakes [15, 42, 125, 127, 128], vertical slats [15, 42, 127, 131], or perforated shrouds [42, 127]. Various hydrodynamic excitation suppression devices have also been considered [9]. For bridge vibrations special flow control vanes [133] and other modifications of aerodynamic forces using openings in upper and lower bridge deck surfaces [134] have proved successful.

Added structural or viscous damping has also been studied [39, 47, 57, 75, 81, 122, 189, 196, 204]. Changes in stiffness have been considered [47, 126] as has the use of tuned mass dampers or vibration absorbers [46, 86, 90, 95, 110, 126, 133, 181, 187]. Of particular interest are the use of a water tank in a building as a tuned mass damper [86] and a wind tunnel study of a conventional tuned mass damper [90]. A unique form of damper comprises a hinged extension (to the top of a tall mast) that incorporates rotational springs and a viscous damper at the hinge [95]. A positive benefit is predicted for vortex shedding.

Transmission line problems have been considered [39]. New material was given on the review and analysis of a single conductor in a coupled two-degree-of-freedom method. An extension to a bundled conductor and a report of new data on the WINDAMPER used to control galloping were also given.

Many studies have been reported on the use of active control technology. A broad study [181] concluded that semi-active systems are superior to conventional passive control and are perhaps comparable to active control systems. An active control system has been proposed [110] that presents a systematic approach to the analysis of such a system; an example was given. Comparisons were made with passive tuned mass dampers (TMD).

Other detailed studies are available [13, 37, 66, 98, 144, 149, 161, 171, 172, 176, 204 h]. One sequence of papers [66, 98, 149, 161] explored active control of in-line

turbulence-excited vibrations by rooftop aerodynamic flap devices [66, 161] or tendons [98, 149]. Tendons are thought to provide a more efficient control but may need larger forces than an active TMD [149]. Design for optimal control forces for both systems was illustrated for linear and nonlinear structural behavior.

CONCLUSIONS

The literature since late 1981 has been cited and selectively reviewed. Significant advances have been made in analysis and model and full-scale testing. Developments in passive and active control technology are also noteworthy.

TABLE 1. SOURCES OF INFORMATION

References	Journal/Conference	Period/Date
1-39	The Shock and Vibration Digest	Jan 82 - Dec 84
40-100	J. Wind Engineering and Industrial Aerodynamics	Jan 82 - Dec 84
101-135	J. Engineering Structures	Oct 81 - Dec 84
136-170	ASCE J. Struc. Div./Struc. Engrg.	Nov 81 - Dec 84
171-187	ASCE J. Engineering Mechanics	Oct 81 - Dec 84
188-193	J. Sound and Vibration	Sept 81 - Aug 84
194-196	J. Earthquake Engrg. and Struc. Dynamics	Jan 82 - Dec 84
43-53	5th Colloquium on Ind. Aerodynamics [200]	June 82
201(a) - (g)	Intl. Conf. on Flow Induced Vibrations [201]	Sept 82
59-94	6th Intl. Conf. on Wind Engineering [202]	March 83
113-135	Conf. on Design Against Wind-Induced Failure [203]	Jan 84
204(a) - (t)	3rd Intl. Conf. on Tall Buildings [204]	Dec 84

TABLE 2. REFERENCES ACCORDING TO STRUCTURAL CONFIGURATION

Structure	References
Isolated Circular Cylinders/Chimneys	4, 15, 16, 19, 22, 23, 31, 35, 42, 54, 55, 75, 76, 92, 106, 113, 122, 123, 124, 125, 127, 128, 130, 131, 153, 180, 196, 201
Arrays of Cylinders	15, 52, 74, 126, 185
Non-Circ. Cylinders	26, 32, 49, 50, 58, 61, 62, 192, 193, 201
Buildings	6, 7, 8, 13, 21, 28, 29, 37, 46, 47, 48, 53, 59, 60, 61, 63, 64, 65, 66, 68, 72, 86, 90, 93, 94, 98, 101, 102, 103, 105, 109, 110, 111, 113, 114, 115, 117, 135, 136, 137, 138, 143, 144, 149, 158, 161, 164, 166, 167, 168, 171, 172, 173, 174, 176, 177, 181, 184, 187, 195, 201, 204

(continued)

TABLE 2 (continued)

Bridges	11, 14, 18, 20, 33, 36, 78, 79, 80, 81, 82, 91, 96, 97, 104, 132, 133, 134, 154, 175, 178, 179, 194, 201
Towers and Masts	12, 57, 87, 88, 95, 116, 120, 129, 156, 170
Cooling Towers, Tanks, Shells	56, 67, 73, 77, 107, 118, 142, 148, 182, 186, 190, 191, 204
Transmission Lines/Cables	5, 16, 17, 24, 25, 27, 38, 39, 83, 84, 85, 113, 140, 169, 188, 189
Roofs and Cladding	34, 41, 43, 69, 70, 71, 112, 113, 121, 143, 145, 146, 157
Off Shore Structures	9, 10, 89, 160
Inflated/Membrane Structures	44, 45, 99, 100

TABLE 3. REFERENCES ACCORDING TO PHENOMENON

Phenomenon	References
Nature of Wind	30, 40, 51, 139, 140, 141, 150, 151, 155, 159, 163, 165, 197, 198, 199, 204
Special Fluid Mechanisms	17, 65, 74, 131, 143, 147, 152, 180, 185, 201, 204
Vortex Shedding	4, 9, 10, 11, 15, 16, 19, 22, 23, 24, 27, 35, 49, 50, 52, 54, 55, 58, 62, 74, 76, 80, 81, 83, 84, 85, 87, 91, 92, 95, 104, 105, 106, 111, 122, 123, 124, 125, 126, 127, 128, 129, 130, 133, 134, 138, 153, 154, 174, 180, 185, 188, 192, 193, 196
Ovalling Vibrations	73, 190, 191
Torsional Vibrations	37, 61, 63, 72, 174, 192, 204
Galloping Vibrations	11, 17, 24, 25, 26, 27, 32, 38, 39, 49, 74, 80, 81, 129, 131, 134, 193, 201
Flutter	11, 14, 20, 34, 36, 50, 58, 69, 70, 71, 79, 80, 97, 104, 134, 154, 192, 194, 201
Divergence, Static Buckling/Stress	44, 45, 67, 100, 107, 112, 121, 142, 157, 182, 204
Turbulence/Buffet Response and Fatigue	5, 6, 10, 11, 12, 14, 18, 19, 21, 27, 28, 29, 30, 31, 33, 36, 43, 44, 45, 48, 53, 56, 59, 62, 63, 65, 66, 68, 72, 77, 78, 81, 82, 87, 88, 89, 93, 94, 95, 96, 98, 99, 105, 108, 110, 111, 115, 116, 117, 118, 119, 120, 128, 135, 136, 137, 138, 145, 146, 148, 149, 153, 156, 158, 160, 161, 164, 166, 167, 168, 169, 170, 173, 175, 176, 177, 178, 179, 184, 186, 197, 198, 199, 201, 204
Full Scale Tests	7, 8, 15, 25, 56, 59, 60, 63, 64, 65, 75, 78, 86, 88, 96, 104, 123, 124, 126, 128, 129, 172, 178, 204
Alleviation Techniques	9, 13, 15, 27, 35, 37, 42, 46, 47, 57, 66, 75, 81, 84, 86, 90, 95, 98, 101, 102, 103, 109, 110, 122, 125, 126, 127, 128, 131, 133, 134, 144, 149, 161, 171, 172, 176, 181, 187, 189, 196, 204

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BOOK REVIEWS

NOISE REDUCTION

L.L. Beranek, Ed.
Robert E. Krieger Pub. Co., Inc.
Melbourne, FL
1980, 752 pages, $45.00

Noise Reduction is a reprint of a book originally published in 1960 that has become a classic on the subject. It identifies the fundamental principles of acoustics and noise control and thus will continue to be a valuable reference source.

The book consists of a series of papers that read well from one chapter to the next. Each chapter contains many graphs, figures, worked examples, and references. The text is divided into four basic parts. The first part is concerned with sound waves and their measurement. The eight chapters cover sound wave behavior, decibels and levels, types of transducers, and sound measurement concepts. The reader soon realizes that some of the material is outdated, particularly the photographs of some of the measurement equipment and use of a reference power of 10-13 watt with sound power level. There is no discussion of acoustic intensity measurement techniques.

Part two covers fundamentals of noise control. The ten chapters address sound propagation outdoors, sound in small and large enclosures, acoustic materials (their properties, architectural uses) and waves in the structures containing them, reactive and dissipative mufflers, and vibration isolation.

Part three is relatively short due to its newness at the time of the original printing. The two chapters contain damage-risk criteria for hearing and criteria for noise and vibration in building structures and vehicles. If this book is ever revised, this part will definitely have to be rewritten and updated. The reader should consult more up-to-date texts or published standards from national and international standards groups for criteria for noise and vibration control.

Part four spans five chapters that contain informative examples and case histories of practical noise control. Examples include noise control in ventilation systems and transportation, machine and shop quieting, office buildings, and homes. One chapter also addresses jet noise sources from aircraft engines and the importance of noise control measures.

This text is still a valuable reference source and is recommended as such. It is worthwhile to have this classic text available as a reprint. Its use in the classroom is recommended as long as shortcomings on sound measuring systems and instrumentation and criteria for noise and vibration control are realized and supplemented with more current material.

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SEISMIC EFFECTS IN PVP COMPONENTS

V.N. Shah and D.C. Ma, Eds.
ASME, New York, NY
PVP-Vol. 88, H00302
1984, 109 pages,

This book contains eight papers that were presented at the 1984 Pressure Vessel and Piping Conference and Exhibition in San Antonio, TX. The papers are divided into two groups. The first group consists of the following:

"Modal Combination in Response Spectrum Analysis of Piping Systems," A.K. Gupta and J-W. Jaw

"Equipment Modeling in Piping Dynamic Analysis," P. Detroux and L.H. Geraets

"Structural Damping Results from Vibration Tests for Straight Piping Sections," A.G. Ware and G.L. Thinnes

"Influence of Initial Gap and Ratios of Mass and Frequency on Component Seismic Interaction," J. Pop, Jr., A. Al-Dabbagh, M. Amin, and S.L. Chu

The papers deal with new computational methods, mathematical models, and vibration test results that are intended to upgrade current seismic analytical methods for piping components in the energy industry. Improved accuracy and reduced conservation of approach are the thrusts of the papers.

The first paper presents a modal combination method that improves the accuracy of the response spectrum analysis of piping systems. The second paper contains two analyses that include attached equipment flexibilities in the response spectrum for a piping system. The third paper reports on the results of a vibration test program that provided best-estimate values for structural damping in nuclear power plant piping systems. The last paper describes an organized way to identify critical components for seismic interaction.

The second group consists of the following:

"Seismic Testing and Analysis for Pool Type LMFBR Reactor Structures," S. Yamamota, H. Kondo, S. Fujimoto, Y. Sasaki, H. Shimizu, S. Hattori, A. Sakurai, Y. Mashiko, and C. Kurihara

"Seismic Response Analysis with Liquid-Structure Interaction," L.P. Harrop and R.G. Thomas

"Seismic Models for Buried Tanks," A.J. Philippacopoulous, C.J. Constantiono, and C.A. Miller

"Seismic Fluid-Structure Interaction Analysis of a Large LMFBR Reactor," D.C. Ma, J. Gvildys, and Y.W. Chang

The papers address the general topic of seismic analysis of liquid-filled structures, including both above-ground and below grade structures. The first and last papers deal with liquid-metal fast-breeder reactor seismic analysis. The second and third papers deal with liquid-filled tanks subjected to seismic disturbances. The tanks are vertical above ground and horizontal below-ground respectively. The latter paper is sufficiently general to be a useful document for such agencies as the EPA. They are concerned with seismic disturbances of waste storage tanks, particularly underground storage system.

The book is recommended to structural engineers who deal with seismic disturbances of fluid storage structures and piping systems.

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OPTICAL AND ACOUSTIC WAVES IN SOLIDS — MODERN TOPICS

M. Borissov, Ed.
World Scientific Pub. Co.,
Distributed by Heyden & Sons, Inc.,
Philadelphia, PA, 1983, 483 pages, $67.00

Acoustic and optical waves have been used over the years as a scientific measuring tool. It is only in the past 10 to 15 years that they have been successfully applied to solids. Applications include solid state electronics; transport of displacement waves (phonons in solids); effects of optical nonlinearities on surface electromagnetic (optical) waves; measurement of acoustic wave propagation characteristics and their changes as a result of phase transitions in crystals; and amplification and instability of surface electromagnetic waves in solids caused by DC electric current.

These topics and many others were part of the second biennial meeting of the International School on Condensed Matter Physics (ISCMP) held 23 September -1 October 1982, in Varna, Bulgaria. This school is sponsored by the Institute of Solid State Physics of the Bulgarian Academy of Sciences. The subject of the 1982 meeting was optical and acoustic waves in solids -- modern topics. The agenda was put together by an international council consisting of scientists from Bulgaria, Federal Republic

of Germany, German Democratic Republic, the United States of America, and the Soviet Union. Lectures and poster sessions were used to organize and present the material.

The lectures are the basis of the book. The first lecture deals with solid state physics and the reasons it is now the accelerator of advances in microelectronics. The phenomenon and theory of self-induced transparency were covered in the second lecture. Electromagnetic waves on surfaces and in glasses are subjects of the third, eighth, and tenth lectures. The fourth lecture is an overview of the transport of nonequilibrium phonons. The acoustical study of phase transitions in crystals and problems caused by them are covered in lecture five. Lecture six describes solutions of nonlinear systems and develops exact methods that do not use linearization and perturbation procedures. Ultrasonic and Brillovin techniques are shown in lecture seven to be complementary when phase transitions in certain ferroelectric insulators are studied. Lecture eight discusses the chaotic motion that simple dynamical systems demonstrate under certain conditions. The subject of lecture eleven is second order magneto-optical effects. The twelfth lecture is concerned with experimental problems in optics with inhomogeneities. The last lecture describes optical wave modulation in crystals and contains suggestions for procedures for its study.

Work in this area is relatively new; many discoveries remain to be made. Enough new research will be performed in the next few years to assure another conference.

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RANDOM VIBRATIONS OF ELASTIC SYSTEMS

V.V. Bolotin
Martinus Nijhoff Publishers
The Hague, The Netherlands
1984, 468 pages

This book is a compilation of Bolotin's work on random vibrations and reliability theory of elastic structural elements. It contains both theoretical and experimental aspects of random vibrations. The author addresses such advanced topics as random forced vibrations of nonlinear systems and parametric stochastic stability of linear systems. The style of the book and notations are somewhat different from those used in the West. The eight chapters deal with random processes, random vibrations of time invariant and time variant linear systems, random vibrations of nonlinear systems, reliability theory, and vibration measurements.

Chapter 1 describes sources and statistical functions of random processes and random fields. The tensor product is used to express joint statistical functions. The author identifies quasi-stationary processes as those that have sufficiently slow varying probabilistic characteristics.

Methods for determining probabilistic characteristics of the response of linear discrete and continuous systems are introduced in Chapters 2 and 3. For linear discrete systems the methods are classified in three groups. The first includes moment functions, Green functions (or unit impulse response), and spectral representation. The second group is based on Markov processes and includes Fokker-Planck-Kolmogorov equations and Ito stochastic differential equations. The third group includes numerical statistical simulations of stochastic processes and random fields such as Monte-Carlo simulation. For linear continuous systems the joint spectral density functions of the generalized coordinates of responses are established for stationary external excitations. Random response properties and approximate methods of analysis for linear viscoelastic systems, plates in a field of random pressure, and shells containing compressible fluid are examined in Chapter 3.

Application of the generalized coordinates method requires summation of contributions of all modes responding to a random loading. The asymptotic behavior of high natural frequencies and corresponding modes is treated in Chapter 4. The method assumes self-adjoint boundary value problem with quasi-separable variables. It also requires that the boundary effect does not degener-

ate. In other words, the boundary conditions should not strongly influence the behavior of the eigenfunctions in the inner region of the elastic continuum. Uniqueness of the solution is achieved via a matching operation that is not rigorously justified. It is also suggested that the solution for the inner region of the system and solutions for each boundary should be considered separately. The method is applied to systems described by partial differential equations with constant coefficients. The theory of distribution of natural frequencies and asymptotic approximation is used as a basis for formulation of a method of integral estimates for the analysis of wide-band random vibration. Results of a number of examples are compared with those obtained by the canonical integral representation.

Chapter 5 deals with parametrically excited random vibrations that are caused by a random vibration in system parameters. The main features of deterministic parametric stability are based on an earlier book by Bolotin. The chapter is confined to stochastic parametric stability in terms of moment functions. The method of moment functions is treated for three situations. The first deals with consistent moment differential equations. The second treats moment differential equations that are coupled to lower order moments. The third case constitutes moment differential equations that are coupled to higher order moments and form an infinite hierarchy set. With regard to the third case a number of closure schemes, including cumulant-neglect, are introduced. This reviewer has noticed that there is a typographical error in the closed moment relation (5.64) and it should read

$$m_{jk\ell m} = \sum^{5} m_{\alpha_1\alpha_2\alpha_3\alpha_4} m_{\alpha_5} - 2\sum^{10} m_{\alpha_1\alpha_2\alpha_3} m_{\alpha_4} m_{\alpha_5}$$

$$+ 6\sum^{10} m_{\alpha_1\alpha_2} m_{\alpha_3} m_{\alpha_4} m_{\alpha_5} - 2\sum^{15} m_{\alpha_1\alpha_2} m_{\alpha_3\alpha_4} m_{\alpha_5}$$

$$+ \sum^{10} m_{\alpha_1\alpha_2\alpha_3} m_{\alpha_4\alpha_5} - 24 m_{\alpha_1} m_{\alpha_2} m_{\alpha_3} m_{\alpha_4} m_{\alpha_5}$$

The stability boundaries of systems with one and two degrees of freedom are obtained numerically and compared with analog computer simulation. The random response of nonlinear systems with constant coefficients is treated in Chapter 6. The perturbation method, the Fokker-Planck-Kolmogorov equation approach, stochastic averaging, and the method of equivalent linearization are described and demonstrated with single degree of freedom systems. The author examined the method of moment functions and the resulting infinite coupling. The analysis is restricted to closure at the level of second order moments. Higher order approximations are briefly introduced. The analysis is extended to include random vibrations of nonlinear continuous systems. Equation (6.70) contains a typographical error in one of the last two terms on the left-hand side.

A topic related to random vibration is the reliabilty of mechanical systems under random loading. Chapter 7 deals with the reliability theory of mechanical systems and the basic tools for protecting such systems from vibration effects. The chapter begins with the concept of failure and its relationship to the reliability function, which is defined as the probability of failure-free operation within a certain time interval. Stochastic models of failure include elementary models, Markov models, Poisson's model, and cumulative models. The reliability theory provides some direction for protecting mechanical systems from vibration effects. In this regard, the engineer can use optimization of system parameters and their characteristics, mean square and minimum variance criteria, and vibration isolation. He must also understand phenomenological models of damage, or cumulative damage. These models are based on the concept of a numerical characteristic that measures the degree of damage. The author introduces some aspects of estimating the longevity of mechanical elements subjected to random vibrations.

The last chapter contains an outline of the principles of planning experimental measurements of random vibration fields. The selection of transducers and their optimal location on tested structures are discussed. In principle, the minimum number of sensors required in a certain experiment is

equivalent to the number of terms in the random field series. The author provides an excellent treatment for the analysis of errors encountered in measurements due to the presence of sensors and the methods of correcting these errors.

This book covers a wide range of topics in the area of random vibration. It is a valuable contribution to structural dynamicists and researchers.

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STANDARDS NEWS

Avril Brenig, Standards Manager

ASA Standards Secretariat, Acoustical Society of America
335 East 45 Street, New York, New York 10017

William A. Yost

Parmly Hearing Institute, Loyola University of Chicago, 6525 North Sheridan Road, Chicago, Illinois 60626

American National Standards (ANSI Standards) in the areas of physical acoustics, bioacoustics, mechanical shock and vibration, and noise are published by the Acoustical Society of America (ASA). In addition to these standards, other Acoustical Society standards, a Catalog of Acoustical Standards—ASA Catalog 5-1984, and an Index to Noise Standards-ASA STDS Index 3-1985 (national and international) are available from the Standards Secretariat of the Acoustical Society. To obtain a current list of standards available from the Acoustical Society, write to Avril Brenig, at the above address. Telephone number: (212) 661-9404.

Calendar

The Fall meetings of the ASA standards committees are scheduled for Nashville, Tennessee, November 4–8, 1985.

1985 November 4, ASA Committee on Standards, 7:30 p.m., the Hyatt Regency, Nashville, Tennessee. Meeting of the Committee that directs the ASA Standards Program.

1985 November 6, Accredited Standards Committee S2 on Mechanical Shock and Vibration (also Technical Advisory Group for ISO/TC/108 and IEC/SC/50A), 2:00 p.m., the Hyatt Regency, Nashville, Tennesse. Review of international and S2 activities and planning for future meetings.

1985 November 7, Accredited Standards Committee S12 on Noise (also Technical Advisory Group for ISO/TC43/SC1), 9:30 a.m., the Hyatt Regency, Nashville, Tennesse. Review of international and S12 activities and planning for future meetings.

1985 November 7, Accredited Standards Committees S1 (Acoustics) and S3 (Bioacoustics) (also Technical Advisory Group for ISO/TC/43, IEC/TC/29, and ISO/TC108/SC4) at 1:30 p.m. at the Hyatt Regency, Nashville, Tennesse. The S1 meeting will be held first. Review of S1, S3, and international standards activities and planning for future meetings.

Standards News from the United States

The following news items have been received since the last issue of *Standards News.*

National Bureau of Standards 1986 Budget Request

A total of $120.0 million is included for the Commerce Department's National Bureau of Standards (NBS) in the fiscal year 1986 budget proposal sent to Congress today by President Reagan.

The budget request is $4.0 million less than the bureau's fiscal year 1985 appropriation of $124.0 million. Included are program increases totaling $16.4 million and cost-of-living and other built-in changes of $4.9 million. The request also includes proposed program reductions of $16.5 million and decreases of $8.8 million, attributable to the President's Deficit Reduction Program.

According to NBS Director Ernest Ambler, "This proposed budget is the result of the administration's careful evaluation of the bureau's programs and priorities. It reflects the minimum resources we need to continue serving industry, government, and academia.

"The U.S. economy is increasingly dependent on industry's ability to advance and exploit science and technology, and it is NBS' responsibility to lay the measurement foundation that is needed to get this job done. Therefore, we have proposed increases for the most critical areas of research while also proposing decreases in view of overall fiscal constraints. We need to move ahead."

Shielding effectivness of buildings

Electrical engineers and others concerned with the effectiveness of buildings in shielding their interiors from electromagnetic (EM) radiation will be interested in a new publication from NBS. *Building Penetration Project* (NBSIR 84-3009) documents a computer program which calculates building attenuation of EM radiation over the frequency range 10 kHz to 10 GHz. Attenuation is computed from building shape, dimensions, room layout, and the electrical properties of the construction materials; no electromagnetic measurements are required. Although performed for the U.S. Army, the work is applicable to almost any situation where it is desirable to estimate the extent of penetration of EM radiation into a multiroom, one-story building. The 310-page publication, which includes listings of computer programs, is available for $25 prepaid from the National Technical Information Service, Springfield, VA 22161. Order by PB #85-126001.

ANSI receives "C" Flag at White House Ceremony

The American National Standards Institute was awarded a "C" Flag by President Ronald Reagan at a White House ceremony on 10 December. It was accepted by ANSI President Donald L. Peyton. Presentation of the flags is part of the President's Citation Program for Private Sector Initiatives, which recognizes and encourages outstanding contributions to society through voluntary programs.

In a letter to Mr. Peyton, President Reagan said, "Thanks to your efforts, our nation is making better use of our abundant resources, and finding creative solutions to problems of human needs in our communities.... Your organization is one of the first in the nation to receive the 'C' Flag. We hope you will proudly fly this symbol of private sector initiative that tells one and all, 'We can. We care.' May this token of our appreciation inspire others to join you in your noble and public-spirited efforts."

Corporations and voluntary organizations received the flag at the 10 December ceremony. It pays tribute, the White House states, to all the businesses and associations "that are displaying the truly American spirit of volunteerism and community action."

The citation program consists of two levels of recognition. The "C" flag is one. The other is a presentation of presidental citations and awards. In October, ANSI received a Private Sector Initiative Commendation from President Reagan. It recognizes the Institute for its national voluntary standards and certification program and its service as a clearinghouse for nationally coordinated voluntary safety, engineering, and industrial standards.

The President's Citation Program was created to encourage growth in voluntary service programs of businesses, trade associations, and professional societies by saluting outstanding contributions that are already being made. The White House states that it is the first of its awards programs to recognize corporate social responsibility, public-private partnerships, corporate philanthropy, and privatization programs. It was developed by the

President's Advisory Council on Private Sector Initiatives in conjunction with the White House Office of Private Sector Initiatives. It is voluntarily administered by the American Society of Association Executives with the cooperation of the White House and several private sector organizations.

Eldred elected new ExSC officer

ANSI's Executive Standards Council has elected Kenneth Eldred chairman and Richard A. Hudnut vice-chairman. Both men began serving one-year terms on 1 January 1985.

Mr. Eldred is president of Kenneth Eldred Engineering. He has been vice-chairman of the ExSC since 1982 and an ANSI director since 1983. An expert on jet and community noise, Mr. Eldred has published numerous articles on these subjects based on his widely recognized research. He is past president of the Institute of Noise Control Engineering, a Fellow of the Acoustical Society of America, and a member of the National Academy of Engineering, the Institute of Environmental Sciences, and the Society of Automotive Engineers.

The Executive Standards Council supervises one of the Institute's major functions—coordination of the voluntary development of national standards and of U.S. participation in international standards activities.

ASTM Committee plans standards for quieter offices

Philadelphia, PA—The circulation of air is crucial to an office environment, yet, a noisy air conditioner can create quite a disturbance to the employees within.

This is one concern of ASTM Committee E-33 on Environmental Acoustics, a group involved in writing standards to aid in the design of quiet offices.

At the 15–17 October 1984 meetings of E-33 in Norfolk, Virginia, a new task group was formed on Ceiling Insertion Loss Measurements. The group will examine ways to measure how well the noise from an air conditioning unit directly above a suspended ceiling can be isolated from the space below.

According to the Task Group Chairman, Dr. A. C. C. Warnock, industry input is needed to develop a test method, "particularly from architects, mechanical engineers, real estate, and other commercial interests."

To participate on this E-33 task group, or to receive more information, contact Dr. A. C. C. Warnock, National Research Council of Canada, Division of Building Research, Montreal Road, Ottawa, Ontario, Canada, tel.:(613) 933–2305.

Other E-33 areas seeking industry participation

The E-33 Task group on Two-Room Method has prepared a draft method to measure the sound insulation between two rooms sharing a common ceiling and plenum. Laboratories wishing to participate in round robin testing should contact Task Group Chairman Dr. Mark A. Lang, Owens-Corning Fiberglas Corporation, P.O. Box 415, Granville, OH 43023, tel.:(614) 587–8138.

Comments and recommendations are sought from users for possible revisions to recommended Practice E 497 for Installation of Fixed Partitions of Light Frame Type for the Purpose of Conserving Their Sound Insulation Efficiency, and Practice E 557 for Architectural Application and Installation of Operable Partitions.

The Task Group on Airflow Resistance is organizing a round robin test series to provide data on the precision of Test Method C 522 for Airflow Resistance of Acoustical Materials. Laboratories may contact Keith W. Walker, U.S. Gypsum Company, P.O. Box 460, Round Lake, IL 60073, tel.: (312)546–8288.

The next meeting of Committee E-33 will be in Pittsburgh, Pennsylvania on 22–24 April 1985. More information on E-33 committee activities is available from David R. Bradley, ASTM, 1916 Race Street, Philadelphia, PA 19103, tel.:(214)299–5504.

SVIC editorial on criteria and standards

Any person performing a test on new or old equipment recognizes the need for criteria, guidelines, and standards. A number, waveform, or spectrum alone means little when assessing the quality of equipment. Standards provide the mechanism for the use of techniques and methods in acquiring and processing data in a common manner. They establish the process that permits data taken by different investigators to be compared. It is an essential step in forming criteria and levels so desperately needed in the vibration field. I feel that the development of acceptable levels of vibration for equipment is one of immediate challenges of the vibration field.

Even though millions of vibration measurements are being made every year, acceptable levels of vibration are available for only general classes of equipment and special types of excitation. In the case of rotating machinery, vibration levels are available for general equipment for once-per-revolution frequency vibrations. These numbers provide guidelines for engineers but are not useful in assessing the severity of critical vibration problems. The data needed to develop detailed vibration criteria are being gathered. Unfortunately they are used only for the immediate task at hand.

The major reason data are not retained in a useful form is cost. Up to this time it was too costly to record and transmit data to a data bank. The advent of the microprocessor based devices has changed this situation. If data are taken according to standard guidelines it appears that they could be transmitted to a data bank with little extra cost to the plant. These data could be merged with those taken in other plants to provide the large sample needed to develop acceptable vibration levels for specific equipment. All engineers in the present and future would benefit from such a program—similar to that sponsored by the U.S. Navy to develop balancing levels.

While the aforementioned type program has yet to be established on an ongoing basis, there are many organizations including American National Standards Institute involved in the development of standards. Many trade associations and societies such as the American Petroleum Institute and the Society of Automotive Engineers are heavily involved in this work. Those interested in the future of standards and criteria contact one of the organizations and spend some effort on this important work.

Standards News from Abroad

The following news items gave been received since the last issue of *Standards News*.

Characteristics of electrical input circuits for hearing aids subject of IEC World Standard

The problem of hearing disabilities is one of international concern to specialists—a concern that has led to a new IEC standard.

The personal hearing aid, normally worn by most hearing impaired people usually has either an acoustic input through a microphone, or an electromagnetic input, through an induction pick-up coil.

However there is a need, for example, for educational purposes, for an electrical connection between the hearing aid and the electrical output of a signal source, such as a radio, record player, tape recorder, infrared system, or external microphone.

The required characteristics for such an input are given in this standard, Publication 118-6: Hearing aids. Part 6: Characteristics of electrical input circuits for hearing aids. The standard specifies the electrical, marking and safety characteristics of a circuit for an external electrical input to a personal hearing aid in order to ensure compatibility with external electrical or electro-acoustic signal sources.

This standard does not cover the interconnection of the parts of a cros (controlateral routing of signals) or bi-cros hearing aid, when designated as a complete system.

ISO Bulletin features acoustics

The February issue of the ISO Bulletin has a six-page lead article on acoustics. The article provides an introductory review of many areas of acoustics, especially those that pertain to standards. The article could make a nice handout for describing acoustics to nonscience audiences.

Standards approved and published by ANSI

The following standards were approved and published by ASA:

ANSI/ASC S1.6–1984	"Preferred Frequencies, Frequency Levels, and Band Numbers for Acoustical Measurement" (revision and redesignation of ANSI S1.6-1967)

ANSI/ASC S1.40-1984	"Specifications for Acoustical Calibrators"
ANSI/ASC S2.34-1984	"Experimental Determination of Rotational Mobility Properties and the Complete Mobility Matrix, Guide to"
ANSI/ASC S12.6-1984	"Real-Ear Attenuation of Hearing Protectors, Method for the Measurement of the" (revision and redesignation of ANSI S3.19-1974)
ANSI/ASC S2.40-1984	Mechanical Vibration of Rotating Machinery—Requirements for Instruments for Measuring Vibration Severity
ASA STDS INDEX 3-1985	Index to Noise Standards, 3rd edition

International documents on acoustics received in the United States

The documents listed below have been received by the Standards Secretariat of the Society and have been announced to S1, S2, S3, or S12. The document number is listed to the left of each document and the Accredited Standards Committee to which the document was announced is listed in parentheses below the document number. Further information on each document can be obtained from the Standards Secretariat.

The following documents have been received from ISO for vote and comment:

ISO/DIS 7626/1 (S2)	Vibration and shock—Experimental determination of mechanical mobility—Part 1: Basic definitions and transducers
ISO/DIS 5438.2 (S2)	Mechanical vibration and shock—Mechanical mounting of accelerometers
ISO/389 DAD 2 (S3)	Acoustics—Standard reference zero for the calibration of pure tone air conduction audiometers
ISO/DIS 7962 (S3)	Vibration and shock—Mechanical transmissibility of the human body

The following documents have been received from IEC for comment:

IEC/SC 29C (Secretariat) 52 (S3)	Audiometers, Part 1: Pure tone audiometers (revision of IEC 645)

S1 meets in Minneapolis

At the S1 meeting held on 11 October 1984 and chaired by T. F. W. Embleton, the following reports were presented:

S1-1 Standard Microphones and their Calibration—*V. Nedzelnitsky, Chair*

The working group met on Tuesday, 9 October at which time the fifth draft revision of S1.12-1967 incorporating comments received at and subsequent to the Norfolk meeting was distributed.

A final draft is expected to be ready for balloting shortly.

S1-2 Attenuation of Sound in the Atmosphere—*A. M. Marsh, Chair*

Working Group S1-2 met Tuesday morning, 9 October 1984. Measurements of aircraft noise were examined at the Boeing Company and the Douglas Aircraft Company to evaluate the effect of proposed changes to the equations in ANSI S1.26 as well as the method of SAE ARP 866A. Initial results indicated that the proposed revisions to the equations of S1.26 provided better agreement between adjusted 1/3-octave-band sound pressure levels than the equations in the 1978 edition of S.126 or SAE ARP 866A.

Lou Sutherland presented interim results of an alternative analysis of nitrogen and oxygen relaxation effects. The results indicated support for the proposed revisions to the equations in S1.26-1978 except at high concentrations of water vapor where water molecules may be present as dimers rather than monomers as had been assumed in all previous analyses and experiments.

Working Group 24 of ISO TC43, Subcommittee 1, is chaired by Joe Piercy and met in Copenhagen on 21–23 May 1984. WG24 is developing an ISO Standard on Sound Propagation Outdoors and agreed to utilize the method in a revised ANSI S1.26-1978 to specify atmospheric absorption as part of an overall Standard that includes the effects of shielding, atmospheric turbulence, and ground effects.

S1-3 Integrating and Averaging Sound Level Meters—*A. H. Marsh, Chair*

Working Group did not meet during the 1984 October ASA meeting in Minneapolis; instead a meeting will be held in December at INTER-NOISE 84. A rough ninth draft of an ANSI Standard was produced in 1984 August and circulated to the Working Group. A revised version will be discussed at the 1984 December meeting.

S1-4 Measurement of Sound Pressure Levels in Air—*O. H. McDaniel, Jr., Chair*

Working group members are reviewing various standard measurement procedures adopted by eight U.S. States, as well as several SAE standards and procedures developed by OSHA.

S1-5 Band Filter Sets—*L. W. Sepmeyer, Chair*

A draft revision of S1.11-1966 (R 1976) was circulated to S1 for ballot on 16 April 1984. The ballot closed on 16 June 1984.

Comments and a few negative votes on the draft of proposal revision of S1.11 have led to a better approach to achieving a descriptor of digital filter response to sloping spectra. A new draft should be ready for re-submittal to S1 before the end of 1984.

S1-6 Reference Sound Source Calibration—*D. R. Flynn, Chair*

This document, the national counterpart of ISO/DIS 6926, was submitted to S12 for ballot. This working group will now be disbanded.

S1-7 Personal Dosimeters—*J. J. Earshen, Chair*

The second draft of the amended standard (S1.25-1978) scheduled to be circulated for ballot during the summer has been delayed for further revision and inclusions. These include: (a) an appendix containing recommended procedures for investigating response of dosimeters to electromagnetic and radio frequency interference. (This was prompted by a letter of recommendation from the OSHA calibration laboratories in Cincinnati, Ohio.) (b) Several members of the working group strongly urged that pulse range testing be done with waveforms having two frequency components. (c) Modification of the qualification test for thresholding circuits was also urged by members of the working group.

The issues are being addressed in a third revised draft which will be submitted for ballot prior to the spring meeting of ASA.

S1-8 Acoustical and Electroacoustical Vocabulary—*S. L. Yaniv, Chair*

Ms. Yaniv reported prior to the meeting, that she hoped to prepare a draft shortly. This draft will be circulated to the chairs of the respective terminology working groups in S1, S3, and S12 for their review prior to ballot, which was expected before the next meeting.

S1-9 Calibration of Underwater Electroacoustic Transducers—*A. L. Van Buren, Chair*

This working group is charged with revision of S1.20-1972 (R 1977) Procedures for Calibration of Underwater Electroacoustic Transducers. It is planned to complete the draft of S1.20-1972 (R 1977) by the end of 1984.

S1-10 Scales and Ratios for Plotting—*R. W. Young, Chair*

The amended IEC Publication 263, 3rd Edition, Scales and Sizes for Plotting Frequency Characteristics and Polar Diagrams, IEC 263-1982, is now available from ANSI. Mr. Young stated at previous meetings that he intended to draft a similar, but expanded, American National Standard for ballot in S1.

S1-11 Phase Response of Transducers—*V. Nedzelnitsky, Chair*

The members continue to gather information on methods for determining the phase responses of microphones in order to prepare a tutorial journal paper on the subject. It may also prove feasible to produce a paper of standard on relative phase response of microphone systems at low frequencies if a sufficient combination of existing data and data from experiments conducted in the near future can be obtained. A short paper on needs and possibilities for standardization that was requested of the chairman for presentation at Inter-Noise 84 has been written and was distributed at this

meeting. It is hoped that this paper will serve as a focus for subsequent discussion and comment in the future activities of the W.G.

S1-12 Specifications for and Calibration of Instruments to Measure Acoustic Intensity—*A. F. Seybert, and W. R. Thornton, Co-Chairs*

This working group met in Pittsburgh, PA in August 1984. An outline of a draft has been completed by the working group and the first draft is being prepared.

Work Items without Working Groups

(a) General Weighting Network (S1.42-198X): Mr. Flynn was assigned to prepare a draft of a standard (S1.42-198X) giving the amplitude response of A-, B-, C-, D-, and E-weighting networks. Considerable sentiment had been expressed for incorporating phase response and time-domain response in the proposed standard. A draft standard is expected shortly and a new working group (S1-13) assigned to this activity. At the meeting, there was discussion and general agreement that the document being prepared by Mr. Flynn should contain only weighting networks A, B, and C, and specifically should not include the D- and E-weighting networks.

(b) Proposed revision of S1.8-1969 (R 1976) Preferred Reference Quantities for Acoustical Levels: Mr. Embleton will be circulating a draft revision of S1.8 for ballot shortly. (It will use the traditional S1.8 reference values, noting that some are not exact S.I. units and that the proposed standard therefore differs from otherwise similar ISO standards.)

(c) Amendment: Specification for Sound Level Meters ANSI S1.4-1983: At the last meeting an amendment to S1.4-1983, which was prepared by Mr. Wong, was proposed for circulation to S1 ballot. The amendment was not considered imcompatible with S1.4 and the Standards Manager was instructed to investigate the appropriate procedure within ANSI to consider and vote on an amendment to a standard. A ballot was subsequently mailed to S1 on 10 August 1984 and closed on 21 September 1984.

Reports on International Activities

International Electrotechnical Commission (IEC) IEC/TC 29 Electroacoustics and IEC/SC 29C Measuring Devices—*V. Nedzelnitsky, Technical Advisor*

The following document was received for VOTE under the six months' rule by the U.S. Member Body: *IEC/TC 29 (Central Office) 139 (No. of document corrected by IEC to138) Draft—IEC Report 118-110; Guide to Hearing Aid Standards* and announced to S3 (S3/204) on 13 July 1984. Mr. Preves coordinated the comments and recommendations for vote, which was affirmative, conditional on the recommended changes, and submitted to ANSI on 23 August 1984.

The U.S. position was transmitted to IEC on 18 September 1984.

IEC/SC 29D Ultrasonics—*P. D. Edmonds*

Document 29D (Central Office) 24, Report on Investigations on Test Procedures for Ultrasonic Cleaners, has been received for formal approval. This document is identical to the draft that was received earlier and found acceptable. There is no discernible U.S. interest in this document, which is informative only. Formal U.S. approval will be recommended.

The Chairman of the USNC-IEC Safety Coordinating Committee has considered AIUM/NEMA Safety Standard for Diagnostic Ultrasound Equipment and found it suitable for submission to an SC29D working group as a working document for conversion into an IEC Standard. The Secretary of TC29 has issued a *questionnaire 29D(Sec)24* seeking advice on formation of a new working group to handle this document.

S2 meets in Minneapolis

Paul H. Maedel, Jr., Chairman, has submitted the following report on the S2 Committee on Mechanical Vibration and Shock. The committee met in Minneapolis, Minnesota during the Fall meeting of the Acoustical Society in October 1984.

Chairman of the working groups reported on their progress on both national and international standards as follows:

S3-39(S2): Human Exposure to Mechanical Vibration and Shock—*H. E. Von Gierke, Chairman*

Resolutions of the SC4 meeting held in Edinburgh in September are available from the standards Secretariat.

Mr. Bruce Douglas coordinated the U.S. response on ISO/DP 8041; "Third Draft Proposal for Human Response Vibration Measuring Instrumentation." A conditionally negative vote, with comments to follow, was recommended by the Technical Advisor on 6 August 1984.

ISO/DP 8727-ISO/TC 108/SC4 N150, "First Draft Proposals on Standard Biodynamic Coordinate Systems" was announced to S3 and S2 on 1 August 1984. J. C. Guignard coordinated comments on this document. A recommendation for a negative vote, with comments, was submitted to ANSI on 15 October 1984.

S2-63 Vibration and Shock Isolators—*S. Rubin, Chairman*

Mr. Rubin is preparing to revise S2.8-1972, "Guide for Describing the Characteristics of Resilient Mounts" (corresponding to ISO 2017-1972).

S2-65 Balancing Technology—*D. C. Stadelbauer, Chairman* (counterpart to ISO/TC 108/SC1)

Mr. Stadelbauer announced the following:

(1) S2.43, "Criteria for Evaluating Flexible Rotor Unbalance (counterpart to ISO 5343-1983) was published in 1984.

(2) ISO/DIS 2953, "Balancing Machines—Description and Evaluation" was voted affirmative with comments.

(3) The short term revision of ISO 1940-1973, "Balance Quality of Rotating Rigid Bodies" was approved at the Berlin meeting in September.

(4) During the March 1982 meeting of IEC/TC2 in Zurich, Switzerland, joint discussions with ISO were proposed concerning the use of full or half key in rotor shafts during balancing. Subsequently, a joint meeting between ISO/TC 108/SCZ/WG1 and IEC/TC2/WG6 was held on 28 September 1983 in Solna, Sweden. The take of writing a standard on rotor shaft keys was assigned to ISO/TC 108/SC1. S2-65—prepared an initial draft recommending the half key convention for balancing and submitted it to ISO/TC 108/SCI the Berlin meeting.

S2-66 Methods for Analyzing and Presenting Vibration and Shock Data—*J. C. Barton, Chairman*

Mr. Barton has submitted the following report for S2-66 and S2-67:

(1) The U.S. voted approval on ISO/TC 108/SC 2 N67—First Draft Proposal ISO/DP 8608 for "Mechanical Vibration—Road Surface Profiles—Reporting Measured Data." It will be submitted for publication as a Draft International Standard (DIS).

(2) The ISO Working Group (counterpart of S2-67) voted to submit a revised draft of ISO/TC 108/SC2/WG4 N68—"Mechanical Vibration—Rail Track Geometry—Reporting Measured Data." for international vote and comment as a first draft proposal.

(3) Work is continuing on drafts dealing with vibration performance of seating (U.S.).

(4) Pending the voting on a proposed new ISO work item, the Working Group (counterpart of S2-67) will start work on a document dealing with the measurement and analysis of vibration imposed on the passengers and crew of railway vehicles.

S2-67 Measurement and evaluation of Vibration and Shock in Land Vehicles—*J. C. Barton, Chairman* (counterpart to ISO/TC 108/SC/WG4)

The international working group met in Edinburgh in September 1984. See report for S2-66.

Mr. J. C. Barton coordinated comments and recommendations for vote on *ISO/DIS 8002 Mechanical Vibration of Land Vehicles—Methods for Reporting Measured Data* on 15 October 1984.

S2-69 Seismic Testing—*G. E. Heberlein, Chairman* (counterpart to IEC/SC50A/WG8)

The following documents were received for comment by the U.S. Member Body:

(1) IEC SC 50A (Secretariat) 200: "Draft-Basic Environmental Testing Procedures—Test Fe Vibration Time-history Method."

(2) IEC SC 50A (Secretariat) 201: "Draft-Basic Environmental Testing Procedures—Test Fe—Vibration: Sine-beat Method."

Mr. Heberlein coordinated the U. S. response on the above documents. A recommendation of approval, with comments was transmitted on 3 May 1984.

S2-71 Techniques of Machinery Vibration Measurement—*R. J. Peppin, Chairman*

Mr. R. J. Peppin was appointed chairman of this working group. He plans to hold his first meeting late in 1984. Anyone interested in serving on this working group should contact Dr. Avril Brenig.

S2-72 Vibration Testing—*G. Booth, Chairman* (counterpart to ISO/TC 108/WG4 and IEC/SC50 A)

Mr. Booth coordinated comments and recommendations on document IEC (Central Office) 165—Amendment to Publication 68-2-6; "Test Fc and Guidance: Vibration (Sinusoidal)." A recommendation for an affirmative vote, without comment was submitted on 13 August 1984.

S2-73 Characteristics of Damping Materials—*J. Henderson/D. Jones Co-Chairpersons* (counterpart to ISO/TC 108/WG 13)

TC 108/WG 13 met in Berlin in September 1983. A revised document is being prepared for review by ISO/TC 108/WG 13 based on ISO/DP 5405/2.

Mr. L. C. Rodgers has been proposed as the new chairman for this working group, both nationally and internationally.

S2-74 Measurement of Mechanical Mobility—*P. K. Baade, Chairman* (counterpart to ISO/TC 108/WG 14)

Part IV of the series of mobility standards (ANSI S2.34-1984) was approved and published.

The working group is revising S2.35 in cooperation with the international (ISO) counterpart working group, which will meet in Orlando, Florida on 31 January and 1 February 1985.

Mr. Baade coordinated the vote on ISO/TC 108 Third Draft Proposal, ISO DP 7626/2, "Methods for the Experimental Determination of Mechanical Mobility, Part 2, Measurements using single-point translation excitation with an attached vibration exciter." A recommendation for an affirmative vote, without comment, was submitted to ANSI on 4 June 1984.

S2-76 Measurement and Evaluation of Machinery Vibration—*P. H. Maedel, Jr., Chairman* (counterpart to ISO/TC 108/SC2/WG1)

Several meetings of the working group were held prior to the international meeting in Berlin in September. The following actions were taken at the Berlin meeting:

ISO/DIS 7919/1 Mechanical Vibration of Non-Reciprocating Machines—Measurements on Rotating Shafts and Evaluation—Part 1: General Guidelines were approved.

It was agreed that ISO 2372-1974, Mechanical Vibration of Machines with Operating Speeds from 600 to 12 000 rpm—Basis for Specifying Evaluation Standards would undergo major revisions to include machines of all speed ranges. The United States delegation raised the question as to whether the vibration severity velocity should be measured as a "zero to peak" value as well as the "root-mean-square" value. Comments are solicited based on your practice in the U.S.

The following action was taken on ASA documents in the system.

(1) ASA S2.40-1984, "Mechanical Vibration of Rotating and Reciprocating Machinery—Requirements for Instruments to Measure Vibration Severity" (counterpart to ISO 2954-1975) was approved in 1984.

(2) The negative ballots on ASA S2.41-198x; "Mechanical Vibration of Large Rotating Machines with Speed ranging from 10 to 200 rps—Measurement and Evaluation of Vibration Severity *In Situ*" (counterpart to ISO 3945-1977) were resolved and the document should be published early in 1985.

S2-77 Measurement and Evaluation of Ship Vibration—*E. Noonan, Chairman* (counterpart of ISO/TC 108/SC2/WG 2)

ISO/TC 108/SC2/WG 2 met in Edinburgh, Scotland in September and discussed the following documents:

(1) Vibration testing of lightweight equipment for shipboard use.

(2) Measurement and analysis of ship vibration.

S2-78 Measurement and Evaluation of Structural Vibration—*S. Ying, Chairman* (counterpart of ISO/TC 108/SC2/WG 3)

ISO/TC 108/SC2/WG 3 met in Edinburgh in September and discussed the following document:

ISO/DP 4866 Third Draft Proposal for Building Vibration—Guide for the Use of Basic Standard Methods of Measurement and Evaluation of Vibration Effects on Buildings.

S2-87 Shock Testing Machines (*Chair Vacant*)

This working group has been established to coordinate activity with the international working group (TC 108/WG 15) which has produced a first draft namely:

ISO/DP 8568 Shock Testing Machines—Characteristics and Performance. Mr. Tillou coordinated the response which was a negative vote for U.S. with comments.

SHORT COURSES

AUGUST

BASICS OF VIBRATION DAMPING TECHNOLOGY
Dates: August, 1985
Place: Dayton, Ohio
Objective: A four day intensive seminar/workshop on basic damping technology, including viscoelastic material behavior, nomograms for representing effects of frequency and temperature on real material behavior, single degree and multiple degree of freedom systems, free layer, constrained layer and discrete damping techniques, and measurement basics will be given. Highlights include a new textbook on vibration damping, extensive use of participant exercises, worksheets and calculator applications to reinforce the learning process, and detailed evaluation of case histories. Attendance will be strictly limited to ensure an intensive and interactive work experience.

Contact: Dr. D. Jones, Damping Technology Information Services, Box 33514, Wright-Patterson AFB, OH 45433-0514.

MECHANICAL ENGINEERING
Dates: August 12-16, 1985
Place Carson City, Nevada
Objective: This course is designed for mechanical, maintenance, and machinery engineers who are involved in the design, acceptance testing, and operation of rotating machinery. The seminar emphasizes the mechanisms behind various machinery malfunctions. Other topics include data for identifying problems and suggested methods of correction.

Contact: Customer Information Center, Bendy Nevada Corporation, P.O. Box 157, Minden, NV 89423 - (702) 782-3611, Ext. 9243.

MODAL TESTING OF MACHINES AND STRUCTURES
Dates: August 13-16, 1985
Place: Nashville, Tennessee
Objective: Vibration testing and analysis associated with machines and structures will be discussed in detail. Practical examples will be given to illustrate important concepts. Theory and test philosophy of modal techniques, methods for mobility measurements, methods for analyzing mobility data, mathematical modeling from mobility data, and applications of modal test results will be presented.

Contact: Dr. Ronald L. Eshleman, Director, The Vibration Institute, 101 West 55th Street, Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254.

MACHINERY VIBRATION ANALYSIS
Dates: August 13-16, 1985
Place: Nashville, Tennessee
Dates: Oct. 29 - Nov. 1, 1985
Place: Oak Brook, Illinois
Objective: This course emphasizes the role of vibrations in mechanical equipment instrumentation for vibration measurement, techniques for vibration analysis and control, and vibration correction and criteria. Examples and case histories from actual vibration problems in the petroleum, process, chemical, power, paper, and pharmaceutical industries are used to illustrate techniques. Participants have the opportunity to become familiar with these techniques during the workshops. Lecture topics include: spectrum, time domain, modal, and orbital analysis; determination of natural frequency, resonance, and critical speed; vibration analysis of specific mechanical components, equipment, and equipment trains; identification of machine forces and frequencies; basic rotor dynamics including fluid-film bearing characteristics, instabilities, and response to mass unbalance; vibration correction including balancing; vibration control including isola-

tion and damping of installed equipment; selection and use of instrumentation; equipment evaluation techniques; shop testing; and plant predictive and preventive maintenance. This course will be of interest to plant engineers and technicians who must identify and correct faults in machinery.

Contact: Dr. Ronald L. Eshleman, Director, The Vibration Institute, 101 West 55th Street, Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254.

BALANCING OF ROTATING MACHINERY
Dates: August 13-16, 1985
Place: Nashville, Tennessee
Objective: This course will emphasize the practical aspects of balancing in the shop and field including training on basics, the latest techniques, and case histories. The instrumentation, techniques, and equipment pertinent to balancing will be elaborated with case histories. Demonstrations of techniques with appropriate instrumentation and equipment are scheduled. Specific topics include: basic balancing techniques (one- and two-plane); field balancing; balancing machines and facilities; use of programmable calculators; turbine-generator balancing; balancing sensitivity; factors to be considered in high speed balancing; effect of residual shaft bow on unbalance; tests on balancing machines; flexible rotor balancing --training and techniques; a unified approach to flexible rotor balancing; and coupling balancing.

Contact: Dr. Ronald L. Eshleman, Director, The Vibration Institute, 101 West 55th Street, Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254.

VIBRATION MEASUREMENT AND MODAL ANALYSIS
Dates: August 15-17, 1985
Place: Amherst, New York
Objective: This course covering dynamic and measurement systems, dynamic signals, applied signal analysis, vibration fundamentals and applied modal analysis will provide engineers with a background in both fundamental and applied aspects of vibration and modal testing. The course will be taught in a lecture/demonstration format making considerable in-class use of state of the art signal analysis and modal analysis instrumentation. Hands on lab experience will be available through informal evening sessions.

Contact: Mike Murphy, Kistler Instrument Corporation, 75 John Glenn Drive, Amherst, NY 14120 - (716) 691-5100.

VIBRATION AND SHOCK SURVIVABILITY, TESTING, MEASUREMENT, ANALYSIS, AND CALIBRATION
Dates: August 26-30, 1985
Place: Santa Barbara, California
Dates: December 2-6, 1985
Place: Santa Barbara, California
Dates: February 3-7, 1986
Place: Santa Barbara, California
Dates: March 10-14, 1986
Place: Washington, DC
Dates: May 12-16, 1986
Place: Detroit, Michigan
Objective: Topics to be covered are resonance and fragility phenomena, and environmental vibration and shock measurement and analysis; also vibration and shock environmental testing to prove survivability. This course will concentrate upon equipments and techniques, rather than upon mathematics and theory.

Contact: Wayne Tustin, 22 East Los Olivos Street, Santa Barbara, CA 93105 -(805) 682-7171.

SEPTEMBER

MACHINERY INSTRUMENTATION AND DIAGNOSTICS
Dates: September 10-13, 1985
Place: New Orleans, Louisiana
Dates: September 24-27, 1985
Place: Anaheim, California
Dates: October 8-11, 1985
Place: Philadelphia, Pennsylvania
Dates: October 21-25, 1985
Place: Carson City, Nevada
Dates: November 5-8, 1985
Place: Boston, Massachusetts

Dates: December 3-6, 1985
Place: Houston, Texas
Objective: This course is designed for industry personnel who are involved in machinery analysis programs. Seminar topics include a review of transducers and monitoring systems, machinery malfunction diagnosis, data acquisition and reduction instruments, and the application of relative and seismic transducers to various types of rotating machinery.

Contact: Customer Information Center, Bendy Nevada Corporation, P.O. Box 157, Minden, NV 89423 - (702) 782-3611, Ext. 9242.

OCTOBER

VIBRATIONS OF RECIPROCATING MACHINERY

Dates: Oct. 29 - Nov. 1, 1985
Place: Oak Brook, Illinois
Objective: This course on vibrations of reciprocating machinery includes piping and foundations. Equipment that will be addressed includes reciprocating compressors and pumps as well as engines of all types. Engineering problems will be discussed from the point of view of computation and measurement. Basic pulsation theory --including pulsations in reciprocating compressors and piping systems -- will be described. Acoustic resonance phenomena and digital acoustic simulation in piping will be reviewed. Calculations of piping vibration and stress will be illustrated with examples and case histories. Torsional vibrations of systems containing engines and pumps, compressors, and generators, including gearboxes and fluid drives, will be covered. Factors that should be considered during the design and analysis of foundations for engines and compressors will be discussed. Practical aspects of the vibrations of reciprocating machinery will be emphasized. Case histories and examples will be presented to illustrate techniques.

Contact: Dr. Ronald L. Eshleman, Director, The Vibration Institute, 101 West 55th Street, Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254.

NOVEMBER

MACHINERY INSTRUMENTATION

Dates: November 12-14, 1985
Place: Calgary, Alberta, Canada
Objective: This seminar provides an in-depth examination of vibration measurement and machinery information systems as well as an introduction to diagnostic instrumentation. The three-day seminar is designed for mechanical, instrumentation, and operations personnel who require a general knowledge of machinery informa-tion systems. The seminar is a recommended prerequisite for the Machinery Instrumentation and Diagnostics Seminar and the Mechanical Engineering Seminar.

Contact: Customer Information Center, Bendy Nevada Corporation, P.O. Box 157, Minden, NV 89423 - (702) 782-3611, Ext. 9243.

NEWS BRIEFS: news on current and Future Shock and Vibration activities and events

Call for Papers

INTER-NOISE 86
Cambridge, Massachusetts
July 21-23, 1986

INTER-NOISE 86, the 1986 International Conference on Noise Control Engineering, will be held on the campus of the Massachusetts Institute of Technology on July 21-23, 1986. Professor Richard H. Lyon of the Department of Mechanical Engineering is the General Chairman.

The theme of INTER-NOISE 86 will be "Progress in Noise Control." The conference is being sponsored by the Institute of Noise Control Engineering in cooperation with the School of Engineering at MIT. It will precede the 12th International Congress on Acoustics (ICA) which is being held in Toronto, Canada on July 24 - August 1, 1986.

A Call for Papers has been issued by the conference organizers. Sessions are planned from issues of noise regulation, compliance, and worker protection to fundamental aspects of noise generation and measurement. Papers are especially sought in newer areas of concern such as machinery monitoring and diagnostics, complex acoustic mobility measurement and computational methods for sound radiation and vibration transmission. The conference will, however, cover all areas of noise control engineering.

A major exhibition of instruments, materials and facilities for noise control will also be held in connection with INTER-NOISE 86. William Cavanaugh is the Exhibits Chairman.

The deadline for the receipt of abstracts is October 14, 1985. Abstracts should be mailed to Professor Richard H. Lyon, Chairman, INTER-NOISE 86, INTER-NOISE 86 Secretariat, MIT Special Events Office, Room 7-111, Cambridge, MA 02139.

NINTH INTERNATIONAL SYMPOSIUM ON BALLISTICS
RMCS, Shrivenham, Wiltshire, UK
April 29 - May 1, 1986

The purpose of this Symposium is to bring together scientists and engineers from industry, government and universities through the free world in a search for new ballistic and conventional warhead technologies, theories, analytical techniques, unique and innovative experimental methods and practical ideas representing an advancement in the state-of-the-art.

Major topical areas are propulsion dynamics, launch dynamics, flight dynamics, conventional warhead mechanisms, and terminal effects.

For further information contact: Mr. N. Griffiths, OBE, Head/XT Group, RARDE (Royal Armament Research and Development Establishment), Fort Halstead, Sevenoaks, Kent, TN14 7BP, England. Telephone: (0959) 32222, Ext. 2028.

VIBRATION DAMPING WORKSHOP II
Las Vegas, Nevada
March 5-7, 1986

The Vibration Damping Workshop II, sponsored by Flight Dynamics Laboratory of the Air Force Wright Aeronautical Laboratories, is an international symposium and will present recent advancements in vibration damping. The Workshop will consist of four sessions: Materials, Active Control, Passive Damping Concepts, and Structural Design and Damping Identification.

The Workshop is planned to provide a forum for the latest state-of-the-art technology as well as selected tutorial information. Viscoelastic property measurement and representation, high-damped metals, friction damping, damping in composites, analysis and design, applications, experimental veri-

fication, controls-structure-interaction, and payoff/benefits are topics to be discussed.

Selection of papers will be based on an abstract submitted to Dr. Lynn Rogers, AFWAL/FIBA, Area B, Bldg. 45, Room 257, Wright-Patterson Air Force Base, OH 45433 - (513) 255-5664. All authors are reminded that the Vibration Damping Workshop II is an international symposium and all papers must be cleared for unlimited distribution. Also, the status of U.S. Air Force funded contracts on the Damping Design Guide, Passive and Active Control of Space Structures (PACOSS), and Reliability of Satellite Equipment in a Vibroacoustic Environment (RELSAT) will be reviewed.

For further information contact: Mrs. Melissa Arrajj, Administrative Chairman, Martin Marietta Denver Aerospace, P.O. Box 179, Mail Stop M0486, Denver, CO 80201 - (303) 977-8721.

ABSTRACTS FROM THE CURRENT LITERATURE

ABSTRACT CONTENTS

AVAILABILITY OF PUBLICATIONS ABSTRACTED

None of the publications are available at SVIC or at the Vibration Institute, except those generated by either organization.

Periodical articles, society papers, and papers presented at conferences may be obtained at the Engineering Societies Library, 345 East 47th Street, New York, NY 10017; or Library of Congress, Washington, D.C., when not available in local or company libraries.

Government reports may be purchased from National Technical Information Service, Springfield, VA 22161. They are identified at the end of bibliographic citation by an NTIS order number with prefixes such as AD, N, NTIS, PB, DE, NUREG, DOE, and ERATL.

Ph.D. dissertations are identified by a DA order number and are available from University Microfilms International, Dissertation Copies, P.O. Box 1764, Ann Arbor, MI 48108.

U.S. patents and patent applications may be ordered by patent or patent application number from Commissioner of Patents, Washington, D.C. 20231.

Chinese publications, identified by a CSTA order number, are available in Chinese or English translation from International Information Service, Ltd., P.O. Box 24683, ABD Post Office, Hong Kong.

Institution of Mechanical Engineers publications are available in U.S.: SAE Customer Service, Dept. 676, 400 Commonwealth Drive, Warrendale, PA 15096, by quoting the SAE-MEP number.

When ordering, the pertinent order number should always be included, not the DIGEST abstract number.

A List of Periodicals Scanned is published in issues, 1, 6, and 12.

MECHANICAL SYSTEMS

ROTATING MACHINES

85-1264
Computation of Wind Tunnel Wall Effects in Ducted Rotor Experiments
A.L. Loeffler, Jr., J.S. Steinhoff
Grumman Aerospace Corp., Bethpage, NY
J. Aircraft, 22 (3), pp 188-192 (Mar 1985), 9 figs, 9 refs

KEY WORDS: Rotors, Wind tunnel testing

Ducted propellers and turbines operating in a square closed wind tunnel test section are analyzed. A multiple image method is used to account for tunnel wall interference effects and a detailed method of singularities model is used for the ducted rotor. The size of the rotor wake is computed, taking into account the tunnel walls. Several ducted rotor model/wind tunnel dimension ratios are examined, ranging between 0.02 and 0.50. For the near-optimum condition, the ideal turbine power is increased by about 8% for the largest model/tunnel ratio considered.

85-1265
Effects of Friction Dampers on Aerodynamically Unstable Rotor Stages
A. Sinha, J.H. Griffin
The Pennsylvania State Univ., University Park, PA
AIAA J., 23 (2), pp 262-270 (Feb 1985), 6 figs, 13 refs

KEY WORDS: Rotors, Aerodynamic stability, Coulomb friction, Lumped parameter method

The physical concepts and mathematical techniques required to analyze and understand the effects of dry friction on aerodynamically unstable rotor stages have been developed. A lumped parameter model has been chosen for the rotor stage, and the viscous damping associated with each blade is taken to be negative. The nature and amplitude of a stable steady-state response is examined. The maximum transient amplitude for which a bounded response exists is obtained. The maximum negative damping that can be stabilized is calculated. Results are presented for three, four, and five-bladed disks.

85-1266
Application of Modal Superposition in Nonlinear Rotor Dynamic Analysis
B.J. Sullivan, S. Upasani
General Electric Co., 3198 Chestnut St., Philadelphia, PA 19101
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. I, pp 191-197, 3 figs, 15 refs

KEY WORDS: Rotors, Nonlinear theories, Modal superposition method, Modal analysis

In this work an efficient computation scheme is presented for solving rotor dynamic analysis problems in which the forces on the shaft arising from the bearings are nonlinear. In this case the nonlinearities are confined to a small portion of the solution domain, and as shown within, the modal superposition method can be a viable approach. A hypothetical problem involving a mass unbalance in a rotor-bearing preload has been solved using modal superposition. Comparison between linear and nonlinear results have been made.

85-1267
Some aspects of the Application of Mechanical Impedance for Turbomachinery and Structural System Parameter Identification
D.E. Bently, A. Muszynska, D.I.G. Jones
Bently Nevada Corp., Minden, NV 89423
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. I, pp 177-186, 19 figs, 26 refs

KEY WORDS: Rotors, Parameter identification techniques, Mobility method, Dynamic stiffness, Modal analysis

Current modal analysis techniques describe system response behavior in terms of glob-

al properties such as real or complex normal modes, natural frequencies, modal masses and modal damping parameters. These parameters form the elements in a series representation of the receptance or compliance function. This approach is adequate for many purposes. If one requires the use of measured response data for the purpose of determining or identifying numerical values for specific physical parameters of the system, such as discrete mass, stiffness or damping elements, the mechanical impedance concepts such as dynamic stiffness are far more useful. This paper describes some applications of the dynamic stiffness approach, including identification of rotor and hydrodynamic bearing parameters of symmetric rotors and identification of discrete parameters for a compressor blade.

85-1268

The Influence of Axial Torque on the Dynamic Behavior of Flexible Rotors (Influence D'un Couple Axial sur le Comportement Dynamique des Rotors Flexibles)

R. Dufour
Laboratoire de Mecanique des Structures I.N.S.A. - Bat. 113 69621 Villeurbanne Cedex, France
112 pp (Feb 22, 1985)

KEY WORDS: Flexible rotors, Torsional excitation

The influence of axial torque on the dynamic behavior of flexible rotors is studied. Regions of instability and forced vibration response of a flexible rotor due to torque excitation were studied. A series of experiments were conducted to verify the computations.

85-1269

Modal Parameters Identification of a Flexible Rotor-Journal Bearing Structure

K.A.F. Moustafa, K.R. Asfar
Yarmouk Univ., Irbid, Jordan
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. I, pp 601-607, 2 figs, 2 tables, 12 refs

KEY WORDS: Modal analysis, Flexible rotors, Bearings, Parameter identification techniques

The modeling problem of a flexible rotor-Journal bearing structural system is considered in this paper. On-line modal sweeping identification scheme which tracks the modal parameters in real time is proposed. A single response and a single excitation records are assumed to be the only data available for identification. This simplifies the measurement and instrumentation requirements for experimental work.

85-1270

Vibration of a Variable Cross Section Shaft Carrying Multi-Discs with any Number of Excitations

H.M. Metwally, M. El-Sayed
Alexandria Univ., Alexandria, Egypt
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. I, pp 591-594, 9 figs, 7 refs

KEY WORDS: Modal analysis, Shafts, Variable cross section, Critical speeds

This paper presented the systematic procedures for finding the critical speed and the bending moment in each segment of the vibratory variable cross-section shaft carrying multi discs. Lateral vibrations result from transversal dynamic excitations. The influence coefficients are obtained by using "Castigliano-Theorem." Samples of data for the obtained results are presented.

85-1271

The Influence of Shear Strain and Rotatory Inertia on the Critical Speeds of Single Span Shafts with Uniform Mass

R. Cuntze
M.A.N. - Neue Technologie, Dachauer Strasse 667, D-8000 Munchen 50, Fed. Rep. Germany
Ing. Arch., 54 (5), pp 368-377 (1984), 9 figs, 11 refs (In German)

KEY WORDS: Shafts, Critical speeds, Rotatory inertia effects, Transverse shear deformation effects

Critical speeds of rotating shafts under consideration of shear and rotatory inertia for classical boundary conditions are evaluated. The results are presented as correction curves with shear and rotatory inertia as parameters. It can be shown that a descending shear stiffness causes a decrease in the critical speeds while the effect of rotatory inertia is vanishing. Beside this, the influence of gyroscopic effects on the critical speeds reduces with increasing degree of boundary constraint.

85-1272

A Computer Method for Modal Analysis of Marine Engine Crankshafts

N.D. Ebrahimi
The Univ. of New Mexico, Albuquerque, NM
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. I, pp 569-573, 6 figs, 3 refs

KEY WORDS: Experimental modal analysis, Crankshafts, Marine engines, Torsional vibrations, Natural frequencies

This paper presents a method for determining the torsional natural frequencies and mode shapes of heavy engine crankshafts. These crankshafts are usually idealized as lumped rotors connected by inertialess shafts. Such models are sufficiently accurate as long as the shaft inertia is reasonably small. In some cases such as a heavy marine engine, however, the shafts may be relatively large, and ignoring their inertia may lead to considerable errors. The method presented in this paper is an extension of the Holzer method. For a number of simple cases where analytical solutions are available for comparison, the method has proved to be accurate and computationally efficient.

85-1273

Vibration Analysis of a Rotating Cooling Fan

M. Ghosh, A. Rajamani
Bharat Heavy Electricals Limited, Vikasnagar, Hyderabad-500 593, India
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. I, pp 459-464, 3 figs, 1 table, 7 refs

KEY WORDS: Modal analysis, Fans, Natural frequencies, Membranes, Rotatory inertia effects

This paper describes a transfer matrix approach for the vibration analysis of a rotating cooling fan used in traction motors. A comparison is made between the theoretical and experimental results for natural frequencies of the fan disc. The natural frequencies of the fan assembly and disc (without blades) are compared to study the influence of individual components.

85-1274

Modal Analysis of Airfoil Fan Wheels

A.J. Errett, D.G. Tuttle, J.S. Solecki
Swanson Engrg. Associates Corp., McMurray, PA
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. I, pp 198-204, 11 figs, 1 table, 4 refs

KEY WORDS: Fans, Natural frequencies, Mode shapes, Finite element technique, Modal analysis

A method of calculating mode shapes and frequencies for complicated airfoil fan wheels using three-dimensional finite element analysis is presented. A simplified testing method is described and test results are presented and compared to the analytical results.

85-1275

Improved Method for the Prediction of Centrifugal Compressor Rotational-Tone Noise

R.G. Adams, B.H. Vickers
GA Technologies, Inc., San Diego, CA
Rept. No. GA-A-17545, CONF-840804-22, 9 pp (Apr 1984),
DE84013345

KEY WORDS: Centrifugal compressors, Noise prediction

This paper presents a method of calculating the sound power produced by the action of the impeller vanes from the design parameters of the compressor and the calculated flow loss coefficients. This method develops relationships between the non-dimensional wake width, ratio between the jet and wake velocities and the impeller loss coefficient. This is then applied to the acoustic dipole source term derived in an earlier paper to calculate the sound power produced by the rotating impeller.

85-1276

Rotor-Bearing Dynamic Analysis by Substructural Decoupling

R.P. Andrews, L.K.H. Lu
Westinghouse Electric Corp., Sunnyvale, CA
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. I, pp 187-190, 2 figs

KEY WORDS: Turbines, Transfer functions, Finite element technique, Substructuring methods, Modal analysis

A method is presented which mathematically corrects measured transfer functions to account for differences between operating and test configurations of a turbine-generator on a base structure. A rotor finite element analysis and system test data are combined with a substructural analysis to determine the decoupled equations for the base. The decoupled equations are then recombined with the bearing oil film and rotor equations to calculate the corrected transfer functions.

85-1277

Dynamic Response of a Turbo-Generator Set

A. Craggs, F. Ellyin, R. Pelot
The Univ. of Alberta, Edmonton, Alberta, Canada
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. I, pp 205-212, 5 figs, 2 tables, 5 refs

KEY WORDS: Turbogenerators, Finite element technique, Timoshenko theory, Modal analysis

A computational model of a turbo-generator set has been developed using finite element discretization. A Timoshenko beam element is used to model the axisymmetric shaft allowing for tapered sections and lumping the wheel masses at internal points. The rotor dynamic matrix is grounded by the speed dependent bearing stiffness and damping forces. A modal reduction procedure is employed to reduce the degrees of freedom so that computations may be carried out on a micro-computer. The model is used to calculate eigenvalues and eigenvectors of a turbo-generator set. The natural frequency and mode shapes predicted by the model are found to be in agreement with those observed in an actual 300 MW turbine installed in a power plant.

85-1278

Natural Torsional Modes of the Rotor of a 1500 RPM Turbine Generator Rated 900 MW

R. Bigret, G.J. Coetzee, D.C. Levy, R.G. Harley
Alsthom-Atlantique, France
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. I, pp 213-219, 11 figs, 2 tables, 4 refs

KEY WORDS: Turbogenerators, Torsional vibrations, Natural frequencies, Mode shapes, Modal analysis

Transient torques exerted on the rotors of turbine generators can produce high stresses Operation on the grid can, under certain conditions, affect them by an instability or by a subsynchronous resonance. This article describes studies on the shaft of a 1500 rpm steam turbine generator rated 900 MW. The studies were carried out on a stationary shaftline supported by oil films. The torsional vibrations were measured by accelerometers on the shaft and the last stage blades of the low pressure turbine. The applied harmonic and transient torques and the resultant vibrations were recorded.

85-1279

Analysis of SSME HOPTP Rotordynamics Subsynchronous Whirl

Control Dynamics Co., Huntsville, AL
Rept. No. NASA-CR-171094, 153 pp (Mar 1984), N84-28900

KEY WORDS: Turbomachinery, Whirling, Subsynchronous vibration, Space shuttles

The causes and remedies of vibration and subsynchronous whirl problems encountered in the Shuttle Main Engine SSME turbomachinery are analyzed. Because the nonlinear and linearized models of the turbopumps play such an important role in the analysis process, the main emphasis is concentrated on the verification and improvement of these tools. It has been the goal of this work to validate the equations of motion used in the models are validated, including the assumptions upon which they are based. Verification of the SSME rotor dynamics simulation and the developed enhancements, are emphasized.

85-1280

Natural Frequencies and Mode Shapes of Rotating Structures Using Improved Strain Energy Formulation in Rayleigh-Ritz Method

A. Kaushal, R. Bhat
Concordia Univ., Montreal, Quebec, Canada, H3G 1M8
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. I, pp 574-583, 14 figs, 2 tables, 10 refs

KEY WORDS: Modal analysis, Natural frequencies, Mode shapes, Rotating structures, Rayleigh-Ritz method

Natural frequencies and mode shapes of a rotating uniform cantilever beam are studied using Rayleigh-Ritz method. A general polynomial with arbitrary coefficients, which are to be determined by the application of the Ritz process, is used as the shape function. The variation of natural frequencies with the speed of rotation is plotted for several parameter combinations such as setting angle, hub radius, etc. Mode shapes at different rotational speeds are also plotted.

METAL WORKING AND FORMING

85-1281

The Reduction of Structure-Borne Noise Through the Combined Application of Modal and Signature Analysis Techniques

Jimi Sauw-Yoeng Tjong, T. Moore, Z. Reig
F. Jos. Lamb Company Limited, Windsor, Ontario, Canada
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. I, pp 660-664, 4 figs, 3 tables, 4 refs

KEY WORDS: Modal analysis, Signature analysis, Vibration control, Noise reduction, Machining

The paper describes an investigation to determine an effective and practical method of reducing vibration and noise radiation from a wingbase of a type which is commonly used in the construction of transfer machines. The wingbases were shown to be significant radiators of structure borne noise which was generated by the supported machining head.

STRUCTURAL SYSTEMS

BRIDGES

85-1282

Dynamic Loading and Testing of Bridges in Ontario

J.R. Billing
Ontario Ministry of Transportation and Communications, Downsview, Ontario, Canada M3M 1J8
Can. J. Civ. Engrg., 11 (4), pp 833-843 (Dec 1984), 12 figs, 3 tables, 14 refs

KEY WORDS: Bridges, Design techniques, Standards and codes

The Ontario Highway Bridge Design Code (OHBDC) contains provisions on dynamic load and vibration that are substantially

different from other codes. Dynamic testing of 27 bridges of various configurations, of steel, timber, and concrete construction, and with spans from 5 to 122 m was therefore undertaken to obtain comprehensive data to support OHBDC provisions. Standardized instrumentation, data acquisition, and test and data processing procedures were used for all bridge tests. Data was gathered from passing trucks, and scheduled runs by test vehicles of various weights. Accelerometer responses were used to determine bridge vibration modes, and dynamic amplifications were obtained from displacement or strain measurements.

BUILDINGS

85-1283

Sound Fields Near Exterior Building Surfaces

J.D. Quirt
National Res. Council of Canada, Ottawa, Ontario K1A 0R6, Canada

J. Acoust. Soc. Amer., 77 (2), pp 557-566 (Feb 1985), 16 figs, 13 refs

KEY WORDS: Buildings, Sound transmission

Measurement of sound transmission through a building facade requires determination of the incident sound power. Interpretation of sound pressure level measurements near a facade is, however, complicated by interference between the incident sound waves and those reflected from the facade. Experimental data and a simple mathematical model are used to examine systematic effects associated with reflections from a large flat facade and, subsequently, to investigate deviations from this simple situation. Although the original motivation for the work was the investigation of problems pertinent to measurements of facade sound transmission, many of the results are relevant for other applications involving measurement of noise near a highly reflective surface.

TOWERS

85-1284

Mini-Modal Testing of Wind Turbines Using Novel Excitation

J.P. Lauffer, T.G. Carne, A.R. Nord
Sandia National Labs., Albuquerque, NM 87185

Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. I, pp 451-458, 14 figs, 8 refs

KEY WORDS: Experimental modal analysis, Wind turbines, Towers, Structural modification.

Modal testing of wind turbines can be fairly difficult because placing transducers on tall structures and providing low frequency excitation create problems. Several techniques of low frequency excitation were explored, including impact, wind, step relaxation, and human input. In tests using the mini-modal concept with human excitation, modal frequencies of large turbines have been determined in less than one day.

FOUNDATIONS

85-1285

Dynamic Analysis of Piles and Pile Groups Embedded in Homogeneous Soils

R. Sen, T.G. Davies, P.K. Banerjee
State Univ. of New York at Buffalo, Buffalo, NY

Earthquake Engrg. Struc. Dynam., 13 (1), pp 53-65 (Jan/Feb 1985), 9 figs, 58 refs

KEY WORDS: Pile structures, Soil-structure interaction, Boundary element technique

A boundary element formulation for the dynamic analysis of axially and laterally loaded single piles and pile groups is presented. The piles are represented by compressible beam-column elements and the soil as a hysteretic elastic half-space. The results obtained from the analysis compare favorably with those from alternative analyses, e.g. finite element, but at greatly reduced computational costs.

85-1286
Foundation Piles: Design, Emplacement, and Performance. 1973-September, 1984 (Citations from the BHRA Fluid Engineering Data Base)
NTIS, Springfield, VA
114 pp (Sept 1984), PB84-875640

KEY WORDS: Pile structures, Bibliographies

This bibliography contains citations concerning piles and pileworks design, emplacement or sinking, and behavior in various soils, environments, locations, and applications. Piles, pile driving techniques and equipment, and high and low pile structures are considered. Dynamic response of piles and pileworks to various conditions such as wind, wave, ice, seismicity, soil instability, and long term displacement is also examined.

HARBORS AND DAMS

85-1287
Effects of Reservoir Bottom Absorption and Dam-Water-Foundation Rock Interaction on Frequency Response Functions for Concrete Gravity Dams
G. Fenves, A.K. Chopra
Univ. of California, Berkeley, CA
Earthquake Engrg. Struc. Dynam., 13 (1), pp 13-31 (Jan/Feb 1985), 12 figs, 1 table, 8 refs

KEY WORDS: Dams, Harmonic excitation, Ground motion

The linear response of an idealized concrete gravity dam monolith to harmonic horizontal or vertical ground motion is presented for a range of the important system parameters that characterize the properties of the dam, foundation rock, impounded water and reservoir bottom materials. Based on these frequency response functions, the effects of allluvium and sediments at the reservoir bottom on the response of the dam, including its interaction with the impounded water and foundation rock, are investigated. It is shown that the partial absorption of hydrodynamic pressure waves by the reservoir bottom materials has an important effect on the dynamic response of concrete gravity dams.

PRESSURE VESSELS

85-1288
The Impact of NDE Unreliability on Pressure Vessel Fracture Predictions
F.A. Simonen
Pacific Northwest Lab., Richland, WA 99352
J. Pressure Vessel Tech., Trans. ASME, 107 (1), pp 18-24 (Feb 1985), 5 figs, 2 tables, 21 refs

KEY WORDS: Pressure vessels, Fracture properties, Nondestructive tests

This paper reviews the significant variables of flaw depth, length, location and orientation required for fracture mechanics evaluations of pressure vessel integrity. Results of calculations emphasize pressurized thermal shock and the significance of flaws located at or near the inside surface of the vessel. Results of other evaluation show the importance of accurately locating flaws by NDE. The influence of vessel cladding is emphasized, with the relative significance of flaws through the clad and at various depths below the clad being addressed.

POWER PLANTS

85-1289
Seismic Analysis of a PWR 900 Reactor: Study of Reactor Building with Soil-Structure Interaction and Evaluation of Floor Spectra
F. Gantenbein, J. Aguilar
CEA Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France

Rept. No. CEA-CONF-6977, CONF-8308-05-78, 11 pp (Aug 1983), DE84750617

KEY WORDS: Nuclear reactors, Soil-structure interaction, Floors, Seismic analysis

The purpose of this paper is the evaluation of seismic response and floor spectra for a typical PWR 900 reactor building with respect to soil-structure interaction for soil stiffness.

85-1290

Stochastic Model to Monitor Mechanical Vibrations in Pressurized Water Reactors

D.J. Shieh, B.R. Upadhyaya
Tennessee Univ., Knoxville, TN
Rept. No. CONF-840614-73, 7 pp (1984), DE84014285

KEY WORDS: Nuclear reactors, Stochastic processes

The feasibility of using neutron flux and core-exit temperature signals in PWRs for estimating core coolant flow velocity has been demonstrated.

85-1291

Development of Methods to Predict Both the Dynamic and the Pseudo-Static Response of Secondary Structures Subjected to Seismic Excitations

M. Subudhi, P. Bezler
Brookhaven National Lab., Upton, NY
Rept. No. BNL-NUREG-34545, CONF-840833-3, 5 pp (1984), DE84010284

KEY WORDS: Seismic excitation, Nuclear reactors

Multiple independent support excitation time history formulations have been used to investigate simplified methods to predict the inertial component of response, as well as the pseudo-static component of response of secondary structures subjected to seismic excitations.

85-1292

Modal Analysis of Superphenix Reactor Internal Structures

S. Aita, F. Gantenbein, Y. Tigeot
Informatique Internationale, under contract with CEA/DEMT
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. I, pp 419-424, 5 figs, 3 tables, 4 refs

KEY WORDS: Modal analysis, Nuclear reactor components, Fluid-induced excitation, Data processing

In order to predict the flow induced vibration levels of SUPERPHENIX reactor internal structures, finite element calculation and full scale tests have been carried out. The study concerns the big "thin shell type" internal vessels and correspondent crossings. 3D calculations have been processed using a substructuration method, where each substructure had an axisymmetric geometry. Results showed high modal densities.

85-1293

Sloshing Response of a Reactor Tank with Internals

D.C. Ma, J. Gvildys, Y.W. Chang
Argonne National Lab., IL
Rept. NO. CONF-840833-4, 4 pp (1984), DE84009629

KEY WORDS: Nuclear reactor components, Sloshing

The sloshing response of a large reactor tank with in-tank components is presented. The study indicates that the presence of the internal components can significantly change the dynamic characteristics of the sloshing motion. The higher sloshing frequency reduces the sloshing wave height on the free-surface but increases the dynamic pressure in the fluid.

OFF-SHORE STRUCTURES

85-1294

Fatigue Analysis of Offshore Platforms Subject to Sea Wave Loadings

G.K. Chaudhury, W.D. Dover
University College London, Torrington Place, London WC1E 7JE, UK
Intl. J. Fatigue, 7 (1), pp 13-19 (Jan 1985), 6 figs, 3 tables, 8 refs

KEY WORDS: Drilling platforms, Off-shore structures, Fatigue life

The fatigue damage calculation for random loading on offshore platforms takes the form of a rainflow analysis of the dynamic response of individual members to various sea states. This procedure is lengthy and consequently this paper attempts to provide a theoretical method for determining random load fatigue damage. This dynamic response for many joints leads to a broad band random loading but despite this, previous theoretical methods have simplified the loading to narrow band. This has not been done in the present case; instead, an analysis based on broad band random loading has been produced.

85-1295
Stiffness Properties of Fixed and Guyed Platforms
V.V.D. Nair, D.I. Karsan
Brown & Root, Inc., P.O. Box 3, Houston, TX 77001
ASCE J. Struc. Engrg., 111 (2), pp 239-255 (Feb 1985), 11 figs, 1 table, 3 refs

KEY WORDS: Offshore structures, Drilling platforms, Stiffness coefficients

For deep-water offshore structures, the fundamental period of lateral vibration is a key factor influencing their design feasibility. This period can be controlled by a rational selection of the parameters governing the stiffness of these structures. These parameters and their relative significance in determining the stiffness properties have been identified. The participation of foundation flexibility in influencing stiffness is also investigated. Finally, a concept of insert piles and a strategy for designing deep-water fixed jackets, and guyed towers for stiffness are introduced.

85-1296
Wind-Induced Response Analysis of Tension Leg Platforms
A. Kareem
Univ. of Houston, Houston, TX
ASCE J. Struc. Engrg., 111 (1), pp 37-55 (Jan 1985), 5 figs, 5 tables, 28 refs

KEY WORDS: Drilling platforms, Offshore structures, Wind-induced excitation, Frequency domain method, Time domain method

A procedure is presented for estimating the wind-induced response of tension leg platforms (TLP). Spatiotemporal characteristics of the wind velocity field over the ocean are discussed. It is shown that the wind spectra generally used for land-based structures may not adequately represent wind velocity fluctuations at very low frequencies associated with the compliant modes of a TLP. A new spectral description of the longitudinal wind velocity fluctuations over the ocean is proposed.

VEHICLE SYSTEMS

GROUND VEHICLES

85-1297
On Analysis of Lateral Forced Vibration of Rail Vehicle Truck Running on Rails with Sinusoidal Irregularities.
K. Yokose, K. Thuchiya
Niigata Univ., 8050, 2 nocho, Ikarashi, Niigata, Japan
Bull. JSME, 28 (235), pp 139-147 (Jan 1985), 15 figs, 10 refs

KEY WORDS: Rail-vehicle interaction, Periodic excitation

The lateral forced vibrations observed in a high speed truck when it runs on a rail with sinusoidal irregularity was analyzed theoretically. The analysis revealed that the running stability of truck is affected by wheel tread concentricity, rotational

stiffness of truck, friction of side bearers, the creep coefficient, and viscous damping against truck turning. The calculated results will be helpful for designing of the high speed trucks.

85-1298
Skirt Material Effects on Air Cushion Dynamic Heave Stability
T.A. Graham, P.A. Sullivan, M.J. Hinchey
Univ. of Toronto, Downsview, Canada
J. Aircraft, 22 (2), pp 101-108 (Feb 1985), 12 figs, 24 refs

KEY WORDS: Ground effect machines, Dynamic stability, Viscoelastic properties

An investigation of the effects of the viscoelastic properties of flexible skirt material on the dynamic stability of a plenum chamber air cushion is described. The skirt is a slightly tapered cone, and two materials used for building laboratory-scale models are tested. Dynamic uniaxial tension tests are used to obtain the viscoelastic parameters. A linear stability analysis of the heave dynamics is based on the usual lumped capacitance model, but is modified to include the effect of skirt deformation on cushion volume and hovergap. Large changes in the stability characteristics from those of an inelastic cushion are predicted. The experiments confirm the predictions.

85-1299
Restraint Systems for "Telebus"
H. Appel, H.J. Grunewald
Bundesministerium fuer Forschung und Technologie, Bonn-Bad Godesberg, Fed. Rep. Germany
Rept. No. BMFT-FB-T-83-284, 24 pp (Dec 1983),
DE84751229 (In German)

KEY WORDS: Safety restrain systems, Buses

Four different restraint systems were designed, constructed, built and tested for the use in vehicles built especially for transportation of handicapped persons. A restraint system with rear and side support was chose. This restraint system is characterized by its easy handling and the minimum space requirement. The effectiveness of the chosen system was demonstrated in 31 collision tests.

AIRCRAFT

85-1300
Calculation of Unsteady Aerodynamics for Four AGARD Standard Aeroelastic Configurations
S.R. Bland, D.A. Seidel
NASA Langley Res. Ctr., Hampton, VA
Rept. No. NASA-TM-85817, 80 pp (May 1984), N84-28747

KEY WORDS: Aircraft wings, Airfoils, Aerodynamic characteristics

Calculated unsteady aerodynamic characteristics for four Advisory Group for Aeronautical Research Development (AGARD) standard aeroelastic two-dimensional airfoils and for one of the AGARD three-dimensional wings are reported. Calculations were made using the finite-difference codes XTRAN2L (two-dimensional flow) and XTRAN3S (three-dimensional flow) which solve the transonic small disturbance potential equations. Results are given for the 36 AGARD cases for the NACA 64A006, NACA 64A010, and NLR 7301 airfoils with experimental comparisons for most of these cases.

85-1301
Comparative Measurements of the Unsteady Pressures on Three Oscillating Wing-Tip Models
W. Wagner
Deutsch Forschungs-und Versuchsanstalt fuer Luft-und Raumfahrt e.V.Goettingen, Fed. Rep. Germany
Rept. No. DFVLR-FB-84-7, 68 pp (Jan 1984), N84-28758

KEY WORDS: Aircraft wings, Blades, Aerodynamic characteristics, Wind tunnel testing

Low speed wind tunnel investigations on steady and unsteady pressure distributions of ogee, trapezoidal and tapered wing tips are discussed. A rectangular blade serves as a reference. The decisive parameter variables are angle of attack, frequency and amplitude of the forced harmonic oscillations about the 1/4 axis, and Reynolds number.

85-1302

Subsonic Wing Rock of Slender Delta Wings

P. Konstadinopoulos, D.T. Mook, A.H. Nayfeh

Virginia Polytechnic Inst. and State Univ., Blacksburg, VA

J. Aircraft, 22 (3), pp 223-227 (Mar 1985), 9 figs, 4 tables, 7 refs

KEY WORDS: Aircraft wings, Aerodynamic loads, Equations of motion

Two recent experimental studies investigated the self-excited motion of a flat delta wing that was free to roll about an axis parallel to its midspan chord. In this paper these experiments are simulated numerically. An unsteady vortex-lattice method is used to provide the aerodynamic loads and the equation of motion is integrated by a prediction-correction scheme. The solution provides complete histories of the motion of the wing and the flowfield simultaneously, fully accounting for dynamic-aerodynamic interaction. The present simulation predicts that the symmetric configuration of the leading-edge vortex system becomes unstable as the angle of attack increases.

85-1303

A Comparison of Methods for Aircraft Ground Vibration Testing

D.L. Hunt

SDRC, Inc.

Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. I, pp 131-137, 13 figs, 1 table, 8 refs

KEY WORDS: Experimental modal analysis, Aircraft vibration, Multipoint excitation technique

The recent advances in multiple-input techniques for experimental modal analysis have given the test engineer alternatives for performing aircraft ground vibration tests (GVT). Multiple-input random excitation is one of the methods being used instead of the traditional sine dwell approach. The relative advantages of the random and sine methods are apparent in comparisons made using data from recent aircraft GVT's.

85-1304

Noise Control for Aircraft. 1975-September 1984 (Citations from the INSPEC: Information Services for the Physics and Engineering Communities Data Base)

NTIS, Springfield, VA

229 pp (Sept 1984), PB84-875798

KEY WORDS: Aircraft, Noise reduction, Bibliographies

This bibliography contains citations concerning the techniques for studying and predicting aircraft noise. Noise control techniques, including landing trajectories, noise impacts, and other sources of noise pollution are discussed. Community response to aircraft noise is considered.

85-1305

Field-Incidence Noise Transmission Loss of General Aviation Aircraft Double-Wall Configurations

F.W. Grosveld

The Bionetics Corp., Hampton, VA

J. Aircraft, 22 (2), pp 117-123 (Feb 1985), 13 figs, 1 table, 21 refs

KEY WORDS: Aircraft, Sound transmission loss

Theoretical formulations have been developed to describe the transmission of reverberant sound through an infinite, semi-infinite, and a finite double-panel structure. The model incorporates the

resonance frequency of each of the panels. It is concluded that this frequency region of low-noise transmission loss is a potential interior-noise problem area for propeller-driven aircraft having a double-panel fuselage construction.

85-1306

Application of Stiffened Cylinder Analysis to ATP Interior Noise Studies

E.G. Wilby, J.F. Wilby
Bolt Beranek and Newman, Inc., Cambridge, MA

Rept. No. L-5552, NASA-CR-172384, 132 pp (Aug 1983), N84-33147

KEY WORDS: Aircraft noise, Interior noise, Noise prediction, Noise reduction

An analytical model developed to predict the interior noise of propeller driven aircraft was applied to experimental configurations for a Fairchild Swearingen Metro II fuselage exposed to simulated propeller excitation. The floor structure of the test fuselage was of unusual construction -- mounted on air springs. As a consequence, the analytical model was extended to include a floor treatment transmission coefficient which could be used to describe vibration attenuation through the mounts. Good agreement was obtained between measured and predicted noise reductions when the floor treatment transmission loss was about 20 dB.

85-1307

Study of Methods to Predict and Measure the Transmission of Sound Through the Walls of Light Aircraft. A Survey of Techniques for Visualization of Noise Fields

S.E. Marshall, R. Bernhard
Purdue Univ., Lafayette, IN

Rept. No. REPT-226-14, NASA-CR-173917, 38 PP (AUG 1984), N84-33146

KEY WORDS: Aircraft noise, Noise transmission

A survey of the most widely used methods for visualizing acoustic phenomena is presented. Emphasis is placed on acoustic processes in the audible frequencies. Many visual problems are analyzed on computer graphic systems. A brief description of the current technology in computer graphics is included. The visualization technique survey will serve as basis for recommending an optimum scheme for displaying acoustic fields on computer graphic systems.

MISSILES AND SPACECRAFT

85-1308

Coupled Helicopter Rotor/Body Aeromechanical Stability Comparison of Theoretical and Experimental Results

P.P. Friedmann, C. Venkatesan
Univ. of California, Los Angeles, CA

J. Aircraft, 22 (2), pp 148-155 (Feb 1985), 12 figs, 1 table, 11 refs

KEY WORDS: Helicopters, Resonant response

This paper presents the results of an analytical study aimed at predicting the aeromechanical stability of a helicopter in ground resonance, with the inclusion of aerodynamic forces. The theoretical results are found to be in good agreement with the experimental results, available in the literature, indicating that the coupled rotor/fuselage system can be represented by a reasonably simple mathematical model.

85-1309

Modes of Shock-Wave Oscillations on Spike-Tipped Bodies

W. Calarese, W.L. Hankey
Air Force Wright Aeronautical Labs., Wright-Patterson Air Force Base, OH

AIAA J., 23 (2), pp 185-192 (Feb 1985), 17 figs, 20 refs

KEY WORDS: Shock excitation, Vibration response, Spacecraft

The phenomenon of self-excited shock oscillations on a spike-tipped body at Mach 3 is investigated. Various modes of shock oscillations are observed. For some spike lengths, the shock oscillations are symmetric. For other spike lengths, the shock structure oscillates asymmetrically with respect to the spike's axis. In this case, experimental evidence confirms the presence of standing rotational waves on the body face and spike. Spike configurations resulting in stable shock systems are also observed. Holography and interferometry are used to obtain a detailed flow visualization.

85-1310
Dynamics and Control of Large Flexible Space Structures, Part 7
P. Bainum, A.S.S.R. Reddy, R. Krishna, C.M. Diarra
Howard Univ., Washington, D.C.
Rept. No. NASA-CR-173781, 113 pp (June 1984), N84-28892

KEY WORDS: Spacecraft, Beams, Natural frequencies, Mode shapes

A preliminary Eulerian formulation of the in-plane dynamics of the proposed spacecraft control laboratory experiment configuration is undertaken. Frequency and mode shapes are obtained for the open loop model of the beam system and the stability of closed loop control systems is analyzed by both frequency and time domain techniques.. Environmental disturbances due to solar radiation pressure are incorporated into models of controlled large flexible orbiting platforms.

BIOLOGICAL SYSTEMS

HUMAN

85-1311
On the Dynamical Modeling and Analysis of Head-Neck Systems
Chieh-Sheng Tien
Ph.D. Thesis, Univ. of Cincinnati, 211 pp (1984), DA8425406

KEY WORDS: Head (anatomy), Mathematical models, Computer programs

The model consists of a series of rigid bodies representing the skull, vertebrae, and torso. They are connected by springs and dampers representing disks, ligaments, and muscles. A systematic method for handling the geometry and kinematics is presented. Equations of motion of the model are developed and converted into computer algorithms. A user-oriented computer program UCIN-HEADNECK incorporating the head-neck model was also developed.

85-1312
Assessment of Community Response to Impulsive Noise
P.D. Schomer
U.S. Army Construction Engrg. Res. Lab., Champaign, IL 61820
J. Acoust. Soc. Amer., 77 (2), pp 520-535 (Feb 1985), 10 figs, 11 tables, 13 refs

KEY WORDS: Impact noise, Human response

The U.S. Army Construction Engineering Research Laboratory has completed community attitudinal surveys at two major Army installations. The main purpose of these surveys was to better understand community response to the impulsive noise generated by large Army weapons such as tanks, artillery, or demolition. The results show that an energy type of model such as the C-weighted day/night average sound level is the best available descriptor for community response for these types of impulsive sound.

MECHANICAL COMPONENTS

ABSORBERS AND ISOLATORS

85-1313
Elastic Analysis of Beam-Support Impact

M.A. Salmon, V.K. Verma, T.G. Youtsos
Sargent and Lundy Engineers, Chicago, IL 60603
J. Pressure Vessel Tech., Trans. ASME, 107 (1), pp 64-67 (Feb 1985), 7 figs, 2 refs

KEY WORDS: Supports, Seismic isolation, Piping systems, Nuclear reactor components, Computer programs

The effect of gaps present in the seismic supports of nuclear piping systems has been studied with the use of such large general-purpose analysis codes as ANSYS. Exact analytical solutions to two simple beam-impact problems are obtained to serve as benchmarks for the evaluation of the ability of such codes to model impact between beam elements and their supports. Bernoulli-Euler beam theory and modal analysis are used to obtain analytical solutions for the motion of simply supported and fixed-end beams after impact with a spring support at midspan. The solutions are valid up to the time the beam loses contact with the spring support. Numerical results are obtained which show that convergence for both contact force and bending moment at the point of impact is slower as spring stiffness is increased. Finite element solutions obtained with ANSYS are compared to analytical results and good agreement is obtained.

85-1314
Reduction in Seismic Response with Heavily-Damped Vibration Absorbers
R. Villaverde
Univ. of California, Irvine, CA
Earthquake Engrg. Struc. Dynam., 13 (1), pp 33-42 (Jan/Feb 1985), 5 figs, 11 tables, 17 refs

KEY WORDS: Vibration absorption (equipment), Vibration damping, Buildings, Seismic response

It is shown that two of the damping ratios of certain systems composed of a building and a small attachment in resonance are given by the average of the damping ratios of the two independent components. Numerical solutions are presented to confirm the demonstration, and recommendations are given to calculate the parameters of such systems.

85-1315
Adaptive Suspension Concepts for Road Vehicles
D. Karnopp, D. Margolis
Univ. of California, Davis, CA 95616
Vehicle Syst. Dynam., 13 (3), pp 145-160 (Nov 1984), 10 figs, 5 refs

KEY WORDS: Suspension systems (vehicles)

A class of basically passive suspensions with parameters which can be varied actively in response to various measured signals on the vehicle are analyzed. These suspensions can come close to optimal performance with simpler means than many of the active or semi-active schemes previously proposed.

85-1316
The Chatter of Semi-Active On-Off Suspensions and Its Cure
D.L. Margolis, M. Goshtasbpour
Univ. of California, Davis, CA 95616
Vehicle Syst. Dynam., 13 (3), pp 129-144 (Nov 1984), 10 figs, 10 refs

KEY WORDS: Suspension systems (vehicles), Chatter

Semi-active suspensions are those in which otherwise passively generated damper forces are modulated using feedback control and small amounts of control effort. Recently it was discovered that two-stage, ON-OFF, semi-active control would chatter between the ON and OFF states in a manner similar to bang-bang, active control systems. This chatter is dependent upon the switching algorithm. This paper describes the dynamics of this chatter and suggests alternative control policies for its cure.

SPRINGS

85-1317

Studies on the Insulation Effect of Rubber Springs in Complex Structures in the Acoustic Frequency Range

W. Gerwig
Technische Hochschule, Darmstadt, Fed. Rep. Germany

Rept. No. BMFT-FB-HA-84-1, 195 pp (Mar 1984), N84-29264 (In German)

KEY WORDS: Elastomers, Springs, Machinery noise, Noise reduction

Acoustic insulation effects of rubber springs placed between machines and foundation structures were examined. Modulus of elasticity and damping factor of rubber springs were examined. A parameter study shows that construction modifications of the machine parts cause different effects within four frequency ranges. Results of a computation of structure-born sound velocities of the machine foundation, based on measurements at a test foundation structure before installation of the machine, are given.

BLADES

85-1318

Shock-Free Turbomachinery Blade Design

P.P. Beauchamp, A.R. Seebass
General Electric Co., Lynn, MA

AIAA J., 23 (2), pp 249-253 (Feb 1985), 9 figs, 10 refs

KEY WORDS: Rotor blades (turbomachinery), Supersonic frequencies, Design techniques

A computational method for designing shock-free, quasi-three-dimensional, transonic, turbomachinery blades is described. Shock-free designs are found by implementing Sobieczky's fictitious gas principle in the analysis of a baseline shape. It results in an elliptic solution that is incorrect in the supersonic domain. Shock-free designs are obtained by combining the subsonic portion of this solution with a characteristic calculation of the correct supersonic flow using the sonic line data from the fictitious elliptic solution. The extension of the present method to viscous flow is straightforward given a suitable analysis algorithm for the flow.

85-1319

Response of Steam Turbine Blades Subjected to Distributed Harmonic Nozzle Excitation

J.S. Rao, N.S. Vyas
Embassy of India, Washington, D.C. 20008

Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. I, pp 618-626, 3 figs, 5 tables, 7 refs

KEY WORDS: Experimental modal analysis, Turbine blades, Steam turbines, Fatigue life, Harmonic excitation

A major step towards fatigue analysis of turbine blades is the determination of stress fields on the blade. The present study deals with the case of a typical tapered, twisted, asymmetric, aerofoil cross-section steam turbine blade. It is mounted at a stagger angle on a rotating disc, subjected to harmonic nozzle excitation force distributed along the length of the blade. A general computer program is developed and the variation of blade stress with respect to rotational frequency of the disc, including resonant frequencies, is analyzed. Various harmonic components of the nozzle excitation force are considered.

BEARINGS

85-1320

Design of a Radial Electromagnetic Bearing for the Vibration Control of a Supercritical Shaft

V. Gondhalekar, R. Holmes
Swiss Federal Inst. of Technology, Zurich, Switzerland

IMechE, Proc., 198 (16), pp 235-242 (1984), 10 figs, 3 refs

KEY WORDS: Bearings, Electromagnetic properties, Vibration control

This paper describes the design of a magnetic bearing and elucidates features hitherto not employed by other workers. These include an original approach to the design of the electromagnets and their amplifiers. The software in a digital control system to condition the control signals so as to make the magnets appear to be linear and uncoupled is discussed. The resulting system has features which make it suitable for the control of rotor bearing assemblies.

85-1321

The Significance of Joints on the Stiffness and Damping of Rolling Element Bearings

R. Brodzinski, B.J. Stone

Univ. of Western Australia, Nedlands, 6009, Western Australia

Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. I, pp 584-590, 9 figs, 9 refs

KEY WORDS: Modal analysis, Rolling contact bearings, Joints, Stiffness coefficients, Damping coefficients

Recent work has established that rolling element bearings provide significant levels of damping to spindle systems. It is shown that the joint between the outer-race and housing is the major source of damping. However it is necessary that the stiffness of this joint be such that energy dissipation occurs in the joint. Results are presented for various preloads and methods of further increasing the damping are discussed.

85-1322

Influence of the Fluid Inertia Forces on the Dynamic Characteristics of Externally Pressurized Thrust Bearings. 2nd Report.

Y. Haruyama, A. Mori, T. Kazamaki, H. Mori

Toyama Univ., 3190 Gofuku, Toyama, Japan

Bull. JSME, 28 (235), pp 155-161 (Jan 1985), 9 figs, 7 refs

KEY WORDS: Thrust bearings, Fluid inertia forces

Various approximate solutions and an exact one for the dynamic performance of externally pressurized infinitely long thrust bearings in a laminar flow regime are presented under the assumption of a small harmonic vibration.

85-1323

A Numerical Analysis Method Based on Flow Continuity for Hydrodynamic Journal Bearings

R.W. Jakeman

Lloyd's Register of Shipping, 74 Fenchurch St., London EC3M 4BS, UK

Trib. Intl. 17 (6), pp 325-333 (Dec 1984), 5 figs, 3 tables, 10 refs

KEY WORDS: Journal bearings, Numerical methods

A numerical method of hydrodynamic bearing analysis is presented which is simple in concept, yet capable of development to handle complex situations such as dynamic misalignment. It is similar to the finite difference solution of Reynolds equation, but incorporates a more realistic modeling of cavitation. The approach to a numerical solution is direct, and should facilitate a better 'feel' for the way in which the physical processes are modeled. Results produced with this analysis are compared with other published data for aligned crankshaft bearings and misaligned sterntube bearings.

85-1324

Thermal Characteristics of Misaligned Finite Journal Bearings

Z.S. Safar, M.O.A. Mokhtar, H.J. Peeken

Cairo Univ., Orman, Ghiza, Cairo, Egypt

Trib. Intl., 18 (1), pp 13-16 (Feb 1985), 6 figs, 9 refs

KEY WORDS: Journal bearings, Alignment, Temperature effects

Adiabatic analysis of a journal bearing is presented for maximum allowable misalignment with a length: diameter ratio of one. The direction of journal misalignment is

allowed to vary up to the axial plane containing the load vector. The results show that bearing behavior is significantly affected by journal misalignment. It is also noted that thermal effects are more pronounced for bearings with axial rather than spiral oil inlet grooves.

GEARS

85-1325
A Modification of the Noise Calculating Formula of the Involute Gear
Zhang Ce, Liang Zhong
Tianjin Univ., People's Republic of China
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. I, pp 668-671, 2 figs, 2 tables, 2 refs

KEY WORDS: Modal analysis, Gear Noise

In gear-transmission several resonance domains may appear - making the noise louder. Through a great number of experiments and analysis of the dynamic behavior of gears, a modified formula for gear noise calculating has been deduced in this paper.

FASTENERS

85-1326
Fatigue Strength of a Groove Weld on Steel Backing
K.A. Baker, G.L. Kulak
Univ. of Alberta, Edmonton, Alberta, Canada T6G 2G7
Can. J. Civ. Engrg., 11 (4), pp 692-700 (Dec 1984), 8 figs, 10 refs

KEY WORDS: Welded joints, Fatigue life

In the investigation reported herein, data concerning the fatigue strength of a groove weld with steel backing bar detail have been obtained experimentally. The backing bar was attached with intermittent fillet welds. A finite element analysis has been used to assist in interpretation of the test results. The analysis showed that high local stresses are present at the toe of the fillet weld. However, high stresses also exist at the flush-ground face of the groove weld, and the test results indicated that all fatigue cracks started at this side of the detail.

85-1327
Structural Stiffness and Damping of a Structure Assembled by Bolts (Raideur et amortissement structurels d'un assemblage par boulonnage)
S. Dubigeon, Chang-Boo Kim
Ecole Nationale superieure de Mecanique, Laboratoire Mecanique Structures, 1, rue de la Noe, 44072 Nantes Cedex, France
J. de Mecanique Theor. Appl. 3 (6), pp 879-904 (1984), 17 figs, 12 refs (In French)

KEY WORDS: Bolted joints, Stiffness coefficients, Damping coefficients

A model which will take into account in finite element programs the dissipation of energy in bolt-assembled structures is described. Research was first carried out on a structure made up of two beams linked by plates tightened with a torque wrench. Nonlinear relations are established between the nodal variables of the element and the associated generalized forces for a fixed state established at a selected frequency.

STRUCTURAL COMPONENTS

BARS AND RODS

85-1328
The Influence of a Rise Time of Longitudinal Impact on the Propagation of Elastic Waves in a Bar
M. Naitoh, M. Daimaruya
Muroran Inst. of Technology, 27-1 Mizumoto-cho, Muroran, Hokkaido, Japan

Bull. JSME, 28 (235), pp 20-25 (Jan 1985), 9 figs, 17 refs

KEY WORDS: Bars, Elastic waves, Wave propagation, Longitudinal waves, Impact response

The purpose of this paper is to examine qualitatively and quantitatively the influence of a rise time of longitudinal impact on the propagation of elastic waves in a bar. The adequacy of application of Love's theory for the propagation of longitudinal elastic waves to this problem is discussed by means of the simultaneous measuring of both axial and radial strains at the same stations along a bar.

85-1329
Dynamic Stability of a Bar Under a Random Train of Impulses with Finite Duration
R. Iwankiewicz
Instytut Inzynierii Ladowej Politechniki Wrockawskiej, Wroclaw, Poland
Polish Solid Mechanics Conf., Proc. 25th, Jachranka, 27-31, Aug 1986. Spon. Inst. of Fundamental Technological Res., Polish Academy of Sciences, p 66

KEY WORDS: Bars, Dynamic stability, Pulse excitation

Dynamic stability of an elastic bar under the axial force in the form of a train of impulses with finite duration is considered. The impulses are assumed to have deterministic pulse shapes and to arrive according to the homogeneous Poisson process.

BEAMS

85-1330
Vibration of Tapered Beams
A.K. Gupta
1700 Dell Ave., Campbell, CA 95008
ASCE J. Struc. Engrg., 111 (1), pp 19-36 (Jan 1985), 4 figs, 4 tables, 4 refs

KEY WORDS: Beams, Variable cross section, Stiffness matrices, Mass matrices

Stiffness and consistent mass matrices for linearly tapered beam element of any cross-sectional shape are derived in explicit form. Exact expressions for the required displacement functions are used in the derivation of the matrices. Numerical results of vibration of some tapered beams are obtained using the derived matrices and compared with the analytical solutions and the solutions based upon stepped representation of the beams using uniform beam elements. The significance of the severity of taper within beams upon solution accuracy and convergence characteristics is examined.

85-1331
Vibration of a Beam with Motion Limiting Stops
V. Sundararajan, V.K. Babtiwale
Indian Inst. of Technology, Kanpur, India
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. I, pp 237-241, 10 figs, 5 refs

KEY WORDS: Beams, Motion-limiting stops, Heat exchangers, Modal analysis, Case histories

The impact force between the baffles and the heat exchanger tubes is a good measure of the dynamic interaction between the baffle and the tube.

85-1332
Vibration Tailoring of Advanced Composite Lifting Surfaces
T.A. Weisshaar, B.L. Foist
Purdue Univ., West Lafayette, IN
J. Aircraft, 22 (2), pp 141-147 (Feb 1985), 12 figs, 20 refs

KEY WORDS: Cantilever beams, Layered materials

This paper discusses the free-vibration characteristics of directionally stiffened, laminated composite beam-like structures such as high-aspect-ratio lifting surfaces.

85-1333
Non-Linear Vibration of a Cantilever Beam of Variable Cross-Section
A. Pielorz, W. Nadolski
Institute of Fundamental Technological Res., Polish Academy of Sciences, Warsaw, Poland
Polish Solid Mechanics Conf., Proc. 25th, Jachranka, 27-31, Aug 1986. Spon. Inst. of Fundamental Technological Res., Polish Academy of Sciences, p 131

KEY WORDS: Cantilever beams, Variable cross section, Nonlinear response, Galerkin method

Large amplitude free vibration of an inextensible thin elastic cantilever beam of a variable cross-section is analyzed. Although large deflections and rotations are considered the strains are small.

85-1335
Vibrations, and Static and Dynamic Stability of Circular Arches Subjected to Uniform Vertical Loads
Y. Wasserman
Ben Gurion Univ. of the Negev, Beer Sheva, Israel
Israel J. Tech., 21 (4), pp 171-180 (1983), 3 figs, 4 tables, 17 refs

KEY WORDS: Arches

This work deals with the vibrations and the stability of elastic circular arches loaded by a uniformly distributed vertical load along the span of the arches. The load consists of constant and time-varying portions. The arch is homogeneous and has uniform cross-section. The ends are pinned, clamped, or elastically restrained against rotation.

FRAMES AND ARCHES

85-1334
Experimental Modal Analysis of a Portal Frame in Frequency and Time Domains
F.B. Qian, W.Q. Feng, P.Q. Zhang, T.C. Huang
Univ. of Wisconsin-Madison, WI 53706
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. I, pp 441-450, 9 figs, 8 tables, 5 refs

KEY WORDS: Experimental modal analysis, Frames, Frequency domain method, Time domain method

This paper describes the experimental modal analysis of a portal frame in both frequency and time domains. Two types of complex modes, the in-plane modes and the modes normal to the plane, are investigated. Experimental data have been generated by an impulse acting on the frame in-plane and normal to the plane. The results of natural or damped natural frequencies, damping factors and scaled modes both for the in-plane case and the case normal to the plane have been tabulated, plotted and compared.

PLATES

85-1336
Vibrations of Circular Orthotropic Plates in Affine Space
G.A. Oyibo, E.J. Brunelle
Fairchild Republic Co., Farmingdale, NY
AIAA J., 23 (2), pp 296-300 (Feb 1985), 5 figs, 14 refs

KEY WORDS: Circular plates, Orthotropism, Natural frequencies, Mode shapes

The vibration of an initially compressed plate having a circular geometry and orthotropy is examined in an affine space. Classical linear plate theory and the Hamilton's principle are employed.

85-1337
Four Ways to Determine Modes of Vibration in a Plate
A. Kyosti, L. Ek, N.-E. Molin
S-721 82 Vasteras, Sweden
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. I, pp 627-633, 10 figs, 1 table, 4 refs

KEY WORDS: Plates, Holographic techniques, Impact tests, Finite element technique

Impact Modal Testing with digital electronic equipment and FEM-calculations are used to record modes of vibration in a plate. The merits of each method is discussed.

85-1338
Theory of Ultrasonic Resonances in a Viscoelastic Layer
R. Fiorito, W. Madigosky, H. Uberall
White Oak Lab., Silver Spring, MD 20910
J. Acoust. Soc. Amer., 77 (2), pp 489-498 (Feb 1985), 7 figs, 14 refs

KEY WORDS: Plates, Viscoelastic properties, Elastic properties, Fluid-induced excitation, Ultrasonic resonance

A resonance theory for the acoustic transmission and reflection coefficients of an elastic plate imbedded in a fluid medium is presented.

85-1339
Prediction of Low-Velocity Impact Damage in Thin Circular Laminates
K.N. Shivakumar, W. Elber, W. Illg
Old Dominion Univ., Norfolk, VA
AIAA J., 23 (3), pp 442-449 (Mar 1985), 12 figs, 10 refs

KEY WORDS: Circular plates, Layered materials, Impact response

Clamped circular composite plates were analyzed for static equivalent impact loads The analysis predicted that the failure would initiate as splitting in the bottom-most ply and then progress to other plies.

85-1340
Natural Frequencies and Mode Shapes of Eccentrically Clamped Circular Discs
H.B. Khurasia, V.O.S. Olunloyo
M.A. College of Technology, Bhopal (M.P.) India
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 264-271, 4 figs, 2 tables, 4 refs

KEY WORDS: Modal analysis, Disks, Natural frequencies, Mode shapes, Eccentricity

Circular discs clamped at the inner circular boundary are analyzed for their vibrational characteristics. The analysis is based on the finite element approach. The effect of variation in eccentricity of the circular clamped boundary on the natural frequencies and mode shapes of vibration are fully investigated.

85-1341
Transient Stress in a Circular Disk under Diametrical Impact Loads
T. Jingu, K. Hisada, I. Nakahara, S. Machida
Gunma Univ., 1-5-1 Tenjin-cho, Kiryu City, Japan
Bull. JSME, 28 (235), pp 13-19 (Jan 1985) 8 figs, 8 refs

KEY WORDS: Disks, Impact excitation

This paper deals with the problem of stress waves in a circular disk subjected to two equal and opposite concentrated impact loads at the end points of a diameter. The solution is based on the stress function approach and the Laplace transform method to a two dimensional non-axisymmetrical dynamic problem. The Laplace inverse transforms are accomplished by the evaluation of residue. The results of numerical evaluation are shown graphically as the variation of displacement and stress versus time.

SHELLS

85-1342
Parametric Optimization of Axially Symmetric Visco-Plastic Shell under Dynamic Loading
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Politechnika Krakowska, Instytut Mechaniki i Podstaw Konstrukcji Maszyn, Krakow, Poland
Polish Solid Mechanics Conf., Proc. 25th, Jachranka, Aug 27-31, 1984. Spons. by Inst. of Fundamental Technological Res., Polish Academy of Sciences, p 36

KEY WORDS: Shells, Optimization

The paper is devoted to the shape optimization of the thin-walled, axially symmetric shell made of visco-plastic material. The shell clamped at one end is loaded by the impulse of axial force at the free end and by constant uniform internal pressure.

85-1343
Asymmetric Modes and Associates Eigenvalues for Spherical Shells
A.V. Singh, S. Mirza
Univ. of Western Ontario, London, Canada
J. Pressure Vessel Tech., Trans. ASME, 107 (1), pp 77-82 (Feb 1985) 4 figs, 7 tables, 11 refs

KEY WORDS: Spherical shells, Finite element techniques, Natural frequencies, Transverse shear deformation effects, Rotatory inertia effects

Free asymmetric vibration of spherical shells with clamped and hinged boundary conditions are analyzed using the finite element method. Element stiffness and consistent mass matrices are derived using the improved shell theory, which takes into account the effects of shear deformation and rotary inertia. Natural frequencies for a wide spectrum of shell geometry ranging from shallow cap to hemispherical shell have been computed and are found to be in close agreement with the available data in the literature.

85-1344
Vibrations of Conical Shells with Variable Thickness (continued)
S. Takahashi, K. Suzuki, T. Kosawada
Yamagata Univ., Yonezawa, 4-3-16 Jonan, Yonezawa, Yamagata, Japan
Bull. JSME, 28 (235), pp 117-123 (Jan 1985) 9 figs. 8 refs

KEY WORDS: Conical shells, Variable cross section

In this paper, free vibrations of truncated conical shells with variable thickness are studied by two methods. These results are compared with equations and numerical results of the improved theory published by authors before.

RINGS

85-1345
The Vibrational Characteristics of Force Fitted Ring
Kwang Sic Kim, Kang Nyoun Kim
Han Yang Univ., Seoul, Korea
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 595-600, 3 figs, 4 tables, 4 refs

KEY WORDS: Modal analysis, Circular rings, Flexural vibrations, Bearing races, Vibration control

The effect of radial prestress on the inplane free flexural vibration of a circular ring with symmetric cross section is studied. A frequency formula is presented.

PIPES AND TUBES

85-1346
Vibration Characteristics of Tubes in a Heat Exchanger
J.C. Simonis, D. Steininger
Southwest Research Inst., San Antonio, TX
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 425-430, 6 figs, 1 table, 6 refs

KEY WORDS: Modal analysis, Heat exchangers, Tube arrays, Fatigue life, Case histories

Circumferential tube cracking has occurred in the once-through steam generators used in nuclear power plants. Analyses of failed tubes indicate that a fatigue process induced by tube vibration could cause the leaks. To investigate the vibration amplitude of tube spans during reactor operation, twenty-three tube spans were instrumented with accelerometers and strain gages at Three Mile Island Unit 2. To aid in the interpretation of the operational vibration measurements, tests were performed to determine the predominant resonant frequencies and mode shapes of selected tubes.

85-1347

Dynamics of Tubes in Fluid with Tube-Baffle Interaction

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J. Pressure Vessel Tech., Trans. ASME, 107 (1), pp 7-17 (Feb 1985) 14 figs, 4 tables, 16 refs

KEY WORDS: Tubes, Structure-support interaction

Three series of tests are performed to evaluate the effects of tube to tube-support-plate (TSP) clearance on tube dynamic characteristics and instability phenomena for tube arrays in crossflow. Test results show that, for relatively large clearances, tubes may possess "TSP-inactive modes" in which the tubes rattle inside some of the tube-support-plate holes. The natural frequencies of TSP-inactive modes are lower than those of "TSP-active modes," in which the support plates provide "knife-edge"-type support.

85-1348

Oscillations of Laval Nozzle Flow with Condensation (Part 2, On the Mechanism of Oscillations and Their Amplitudes)

K. Matsuo, S. Kawagoe, K. Sonoda, T. Setoguchi

Kyushu Univ., Kasuga, Fukuoka, 816, Japan

Bull. JSME, 28 (235), pp 88-93 (Jan 1985) 10 figs, 1 table, 6 refs

KEY WORDS: Tubes, Nozzles, Fluid-induced excitation

In the present paper, flow oscillation has been examined experimentally for the case of rapid expansion of moist air, using a Ludwieg tube and a supersonic indraft wind tunnel. As a result, the effects of the initial relative humidity of the moist air and the nozzle geometry on the amplitude of pressure oscillation have been clarified. Furthermore, based on the experimental results, the mechanism of the flow oscillation has been discussed.

85-1349

Dynamic Response of a Buried Pipeline at Low Frequencies

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Univ. of Colorado, Boulder, CO 80309

J. Pressure Vessel Tech., Trans. ASME, 107 (1), pp 44-50 (Feb 1985) 9 figs, 1 table, 10 refs

KEY WORDS: Pipelines, Underground structures, Seismic excitation

A long wavelength and low-frequency analysis is presented here for the dynamic behavior of a long continuous pipeline embedded in an elastic medium. Results are presented showing the dependence of the induced stresses on the direction of propagation of the incident waves, the Poisson's ratios and rigidities of the ground and pipe materials.

85-1350

A Refined Seismic Analysis and Design of Buried Pipeline for Fault Movement

Leon Ru-Liang Wang, Yaw-Huei Yeh

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Earthquake Engrg. Struc. Dynam., 13 (1), pp 75-96 (Jan/Feb 1985) 17 figs, 2 tables, 19 refs

KEY WORDS: Piping systems, Underground structures, Seismic design

This paper presents a refined analysis procedure for buried pipelines that is applica-

ble to both strike-slip and reverse strike-slip faults after modifying some of the assumptions used previously. Based on the analytical results, this paper also discusses the design criteria for buried pipelines which are subjected to various fault movements. Parametric responses of buried pipeline for various fault movements, angles of crossing, buried depths and pipe diameters are presented.

DUCTS

85-1351
Experimental Investigation of Modal Power Distribution in a Duct at High Frequency
S.M. Baxter, C.L. Morfey
Univ. of Southampton, Southampton, UK
AIAA J., 23 (2), pp 172-176 (Feb 1985) 8 figs, 3 refs

KEY WORDS: Ducts, Linings, Sound waves, Wave attenuation

Sound attenuation in a lined duct depends on the distribution of acoustic power among the propagating modes. This paper describes the application of a new data analysis technique for investigating in-duct modal power distributions. The technique is designed for high frequencies, with many more propagating modes present than available data points. Using data from a twelve-point microphone traverse experiment, information has been obtained about the structure of a duct field at frequencies high enough to allow as many as 500 modes to propagate.

BUILDING COMPONENTS

85-1352
Investigations on Influences on the Sound Reduction Index of Windows and Panes in the Test Facilities (Untersuchungen uber Einflüsse auf die Schalldämm-Masse von Fenstern und Scheiben in Prüfständen)
H. Goydke, S. Koch, F.P. Mechel, G. Raabe
Physikalisch-Technische Bundesanstalt, Braunschweig Fraunhofer-Institut f. Bauphysik, Stuttgart
Acustica, 56 (3), pp 169-179 (Nov 1984) 19 figs, 9 refs (In German)

KEY WORDS: Windows, Noise reduction

Experimental results are reported about different factors influencing the results of sound insulation tests with panes and windows. Measurement results from three test facilities in two laboratories are used.

85-1353
Turbulent Wind Forces on a Large Span Roof and Their Representation by Equivalent Static Loads
A.G. Davenport, D. Surry
Univ. of Western Ontario, Faculty of Engrg. Science, London, Ontario, Canada N6A 5B9
Can. J. Civ. Engrg., 11 (4), pp 955-966 (Dec 1984) 8 figs, 3 tables, 4 refs

KEY WORDS: Roofs, Wind-induced excitation

The paper describes the measurement of the steady and fluctuating wind forces on a large span roof and their representation by equivalent static loads.

85-1354
Nonlinear Response to Sustained Load Processes
K.C. Chou, R.B. Corotis, A.F. Karr
Syracuse Univ., Syracuse, NY 13210
ASCE J. Struc. Engrg., 111 (1), pp 142-157 (Jan 1985) 6 figs, 2 tables, 26 refs

KEY WORDS: Structural members, Stochastic processes, Nonlinear response

Reliability analysis of structural members subjected to a stochastic load process is extended to include material nonlinearity. Characteristics of the nonlinear response are computed for a member with a bilinear force-deformation relationship having the unloading range parallel to the initial elastic range.

85-1355
Seismic Response of Light Subsystems on Inelastic Structures
J. Lin, S.A. Mahin
Univ. of California, Berkeley, CA
ASCE J. Struc. Engrg., 111 (2), pp 400-417 (Feb 1985) 10 figs, 3 tables, 20 refs

KEY WORDS: Structural members, Structure-support interaction, Seismic response

Preliminary analyses are performed to obtain insight into the seismic response of light, acceleration sensitive nonstructural subsystems supported on structures that yield during severe earthquake ground motions. The effects of the severity of the inelastic deformations, of different hysteretic characteristics of the structure and of the amount of viscous damping of the subsystem are thoroughly investigated.

85-1356
Dynamic Response of Multiply Supported Secondary Systems
T. Igusa, A. Der Kiureghian
Univ. of California, Berkeley, CA
ASCE J. Engrg. Mech., 111 (1), pp 20-40 (Jan 1985) 6 figs, 7 tables, 22 refs

KEY WORDS: Structural members, Modal synthesis, Tuning, Structure-support interaction, Damping effects

An accurate and efficient method for analysis of multiply supported, multi-degree-of-freedom secondary systems is developed. The method accounts for the effects of tuning, interaction, nonclassical damping, and spatial coupling that are intrinsic dynamic characteristics of composite primary-secondary systems.

85-1357
Transition through Resonances
R.M. Evan-Iwanowski, G.L. Ostiguy
Syracuse Univ., Syracuse, NY 13210
Israel J. Tech., 21 (4), pp 163-170 (1983) 6 figs, 13 refs

KEY WORDS: Resonance pass through, Structural members

The object of this article is to present some analytical and experimental aspects of nonlinear mechanics as manifest in the transition through resonances of some structural elements.

85-1358
Dynamic Characterization of Two-Degree-of-Freedom Equipment-Structure Systems
T. Igusa, A. Der Kiureghian
Univ. of California, Berkeley, CA
ASCE J. Engrg. Mech., 111 (1), pp 1-19 (Jan 1985) 8 figs, 13 refs

KEY WORDS: Equipment-structure interaction, Perturbation theory, Tuning, Damping effects, Structure-support interaction

A two-degree-of-freedom equipment-structure system is studied to find its intrinsic properties which are needed for analysis of more general secondary systems. Perturbation theory is used to find closed form expressions for the modal properties of the system in terms of the properties of the individual subsystems. Three important characteristics of the system are identified: tuning, interaction, and nonclassical damping.

ELECTRIC COMPONENTS

CONTROLS (SWITCHES, CIRCUIT BREAKERS)

85-1359
Centrifuge Tests to Provide Closure Bounds for Switches Subjected to Random Vibration
R. Rodeman, T.G. Priddy
Sandia Natl. Labs., Albuquerque, NM
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 220-222, 1 fig, 1 ref

KEY WORDS: Switches, Centrifuges, Random excitation, Modal analysis, Case histories

A centrifuge test at a constant acceleration level that bounds from above the closure that would be experienced by a normally open switch subjected to a stationary random excitation of fixed duration is derived. Experiments which verify the validity of the bound have been performed.

DYNAMIC ENVIRONMENT

ACOUSTIC EXCITATION

85-1360

High-Frequency Acoustic Variability in the Arctic

M. Schulkin, G.R. Garrison, T. Wen
Univ. of Washington, Seattle, WA 98105
J. Acoust. Soc. Amer., 77 (2), pp 465-481 (Feb 1985) 26 figs, 9 tables, 24 refs

KEY WORDS: Underwater sound, Acoustic intensity method, Sound measurement

Fluctuations in acoustic intensity have been studied for two locations in the Arctic -- the Chukchi Sea (1974) and the Kane Basin (1979) -- using the same measurement and analysis techniques. A five-frequency transducer covering the range 10-75 kHz was moved continuously in the vertical direction from 10-70m. The results were used to determine the vertical correlation length and the coefficient of variation (rms variance) for the intensity at the five frequencies simultaneously.

85-1361

3-Dimensional Acoustic Intensity Measurement by Use of 4 Microphones

N. Okubo, N. Nakane, H. Miyano, Y. Nogiwa
CAMAL, Chuo Univ., Japan
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 652-659, 16 figs, 1 table, 3 refs

KEY WORDS: Acoustic intensity method, Measurement techniques, Multimicrophone technique, Experimental modal analysis

Acoustic intensity measurements in noise analysis, based on cross spectrum method, are becoming more popular because of the similarity in equipment used for both intensity and experimental modal analysis. However, the state of the art is limited to the use of 2 microphones, yielding one dimensional measurement of acoustic intensity. This paper describes the preliminary development of acoustic intensity measurement in 3 dimensional space by using 4 microphones simultaneously. The microphone arrangement used and the computer software developed were confirmed in one, two and three dimensional space in order to make clear its characteristics.

85-1362

An Investigation of the Acoustic-Measuring Line Detector Technique with Fixed-Measuring Points (Untersuchungen zum akustischen Messleitungsverfahren mit festen Messorten)

H. Hudde, U. Letens
Lehrstuhl f. Allgemeine Elektrotechnik und Akustik, Ruhr-Universitat Bochum
Acustica, 56 (4), pp 258-268 (Dec 1984) 17 figs, 9 refs (In German)

KEY WORDS: Acoustic impedance, Measurement techniques, Sound measurement

A special investigation has been undertaken for measuring impedance in an acoustic-measuring tube, in which the sound pressure was measured at several fixed measuring points. Systematic measuring errors were investigated and checked.

85-1363

Studies on Impact Sound (First Report, The Sound Generated by a Ball Colliding with a Plate)

T. Igarashi, M. Goto, A. Kawasaki
Technological Univ. of Nagaoka, Kamitomioka-cho, Nagaoka, Niigata, Japan
Bull. JSME, 28 (235), pp 148-154 (Jan 1985) 15 figs, 2 tables, 9 refs

KEY WORDS: Sound generation, Impact excitation, Noise reduction

This report concerns the impact sound that is produced by the collision of a ball against a plate. The characteristics of impact sound have been clarified, providing an insight into the mechanism of its occurrence.

Experimental values of acoustic wave propagation constant and characteristic impedance in fibrous materials, and normal absorption for two plastic foams, have been compared to theoretical predictions obtained with Biot's theory. It is shown how the formalism used for predicting foams absorption coefficients may be used for studying the acoustic behavior of multi-layered media.

85-1364

Surface Intensity Measurements for the Prediction of Sound Radiation from Structural Modifications

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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 645-651, 9 figs, 16 refs

KEY WORDS: Experimental modal analysis, Sound waves, Wave radiation, Structural modification techniques

A method to predict the change in sound radiation when a physical modification is made to a structure is presented. A system model is developed from simultaneous measurement of the excitation, surface vibration and the near field sound pressure at test locations on a structure. The structural dynamics are extracted by standard experimental modal analysis techniques.

85-1365

Biot Theory and Acoustical Properties of High Porosity Fibrous Materials and Plastic Foams (Théorie de Biot et propriétés acoustiques des matériaux fibreux et des mousses plastiques a forte porosité)

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Acustica, 56 (3), pp 221-227 (Nov 1984) 3 figs, 4 tables, 12 refs (In French)

KEY WORDS: Wave propagation, Sound waves, Biot theory, Fiber composites, Foams

85-1366

An Advanced Computational Method for Radiation and Scattering of Acoustic Waves in Three Dimensions

A.F. Seybert, B. Soenarko, F.J. Rizzo, D.J. Shippy
Univ. of Kentucky, Lexington, KY 40506-46

J. Acoust. Soc. Amer., 77 (2), pp 362-368 (Feb 1985) 9 figs, 29 refs

KEY WORDS: Sound waves, Wave radiation, Wave scattering, Helmholtz integral method

The method proposed in this paper provides a computational method for implementing the Helmholtz integral formula for acoustic radiation and scattering problems associated with arbitrary shaped three-dimensional bodies. In particular an isoparametric element formulation is used in which both the surface geometry and the acoustic variables on the surface of the body are represented by second-order shape functions within the local coordinate system. This result is applicable to nonsmooth bodies.

85-1367

The Acoustic Power of Circular Radiators (Die akustische Leistung von Kreisstrahlern)

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Acustica, 56 (3), pp 214-220 (Nov 1984) 4 figs, 1 table, 12 refs (In German)

KEY WORDS: Sound waves, Wave radiation

The complex acoustic power of sound radiators, placed in an infinitely large baffle,

is computed according to the Huygens-Rayleigh integral. Six simple symmetric and antisymmetric vibrational mode shapes are chosen.

85-1368
Sound Field Fluctuations in a Shallow Water Waveguide
C.S. Clay, Y.-Y. Wang, E.-C. Shang
Univ. of Wisconsin-Madison, Madison, WI 53706
J. Acoust. Soc. Amer., 77 (2), pp 424-428 (Feb 1985) 4 figs, 2 tables, 18 refs

KEY WORDS: Sound waves, Sound transmission, Underwater sound, Waveguide analysis

Experimental measurements of sound transmissions in a laboratory waveguide are analyzed. The transmissions were from a single source to a vertical array of receivers that operated as a mode filter. Water waves on the surface caused the sound fields to fluctuate at the receiver.

85-1369
Noise Reduction in Instrument Technology (Geräuschminderung in der Gerätetechnik)
G. Herklotz, W. Krause, D. Schick, J. Thümmler
Technische Universität Dresden, German Dem. Rep.
Feingerätetechnik, 34 (1), pp 32-35 (1985) 5 figs, 1 table, 10 refs (In German)

KEY WORDS: Noise reduction, Instrumentation

This article is the first in the series of articles dealing with noise generation and reduction in instrumentation. Its aim is to provide development engineers, designers and scientists with the necessary fundamentals as well as methodology in this specialty.

85-1370
Scaling of Airfoil Self-Noise Using Measured Flow Parameters
T.F. Brooks, M.A. Marcolini
NASA Langley Res. Ctr., Hampton, VA
AIAA J., 23 (2), pp 207-213 (Feb 1985) 12 figs, 13 refs

KEY WORDS: Airfoils, Aerodynamic noise

Data from an airfoil broadband self-noise study are reported. Attention here is restricted to two-dimensional models as zero angle of attack to the flow. The models include seven NACA 0012 airfoil sections and five flat plate sections with chord-lengths. Testing parameters include flow velocity and boundary-layer turbulence through natural transition and by tripping. Detailed aerodynamic measurements are conducted in the near-wake of the sharp trailing edges.

85-1371
Sound Hole Sum Rule and the Dipole Moment of the Violin
G. Weinreich
Randall Lab. of Physics, Univ. of Michigan, Ann Arbor, MI 48109
J. Acoust. Soc. Amer., 77 (2), pp 710-718 (Feb 1985) 2 figs, 7 refs

KEY WORDS: Violins, Sound waves, Wave radiation

It is shown both theoretically and experimentally that at long enough wavelengths the radiation pattern of a violin, or of any similar instrument with a sound hole in its shell, becomes that of a dipole. The transition from this region to the one in which the monopole dominates is traced in detail. Absolute measurements of the radiativity are obtained, and their phases and amplitudes explained in terms of the mechanical motions of the violin shell and the enclosed air.

85-1372
The Use of Acoustic Pressure Measurements to Determine the Particle Motions Associated with the Low Order Acoustic Modes in Enclosures
K.P. Byrne

Univ. of New South Wales, Kensington, New South Wales, 2033, Australia
J. Acoust. Soc. Amer., 77 (2), pp 739-746 (Feb 1985) 8 figs, 8 refs

KEY WORDS: Enclosures, Cavities, Sound pressures, Sound measurement,

This paper describes a procedure for experimentally deriving, in terms of the particle motions, the shapes of the low order acoustic modes in enclosures. The procedure is based on finding differentiable functions which approximate the shape functions of the low order acoustic modes when the modes are defined in terms of the acoustic pressure.

85-1373
Studies of Parallel Barrier Performance by Acoustical Modeling
D.A. Hutchins, H.W. Jones, B. Paterson, L.T. Russell
Queen's Univ., Kingston, Ontario K7L 3N6, Canada
J. Acoust. Soc. Amer., 77 (2), pp 536-546 (Feb 1985) 11 figs, 21 refs

KEY WORDS: Noise barriers, Scaling, Test models

An investigation is presented into the performance of parallel barrier configurations, using acoustical scale modeling. A realistic geometry is investigated, with the source being positioned over a paved roadway and the receiver over grass-covered ground. The grass-covered ground surface was properly modeled in terms of its impedance. Results were obtained for a range of barrier types, and demonstrate that frequency dependent effects are evident in barrier insertion loss data. In most cases, the barrier on the far side of the source did not significantly affect sound levels at the receiver. The most effective barrier design was found to be that of a gradual gross-covered slope up to an upright, thin barrier.

SHOCK EXCITATION

85-1374
Some Applied Mechanics Considerations for Design of High-Impact Resistant Structures
W.H. Hoppmann, II, J.C.C. Liu
U.S. Army Materiel Systems Analysis Activity, Aberdeen Proving Ground, MD 21005-5071
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL. Vol. I, pp 679-684, 23 refs

KEY WORDS: Experimental modal analysis, Shock resistant design, Design techniques, Buildings, Ground vehicles

The primary subject of this paper is the application of applied mechanics to problems which arise in the design and development of high-impact resistant structures. To provide greater insight to the problems of intense shock loading, a short treatment of the mathematical and experimental tools for an engineering investigation of the subject is presented. Stress wave and modal analyses are considered.

85-1375
Do-It-Yourself Fallout/Blast Shelter Evaluation
P.T. Nash, W.E. Baker, E.D. Esparza, P.S. Westine
Southwest Res. Inst., San Antonio, TX
Rept. No. UCRL-15605, 172 pp (Mar 1984) DE84013220

KEY WORDS: Protective shelters, Nuclear explosion effects, Blast resistant structures

Expedient fallout shelters recommended to the general public were evaluated for their potential to provide safety to occupants during nuclear blast. The blast threat was in the 2 to 50 psi overpressure range from a 1 megaton yield weapon. Research included a literature search for expedient shelter designs and evaluations of the designs to certify their ability to protect occupants. Shelters were evaluated systematically by first analyzing each design for expected failure loads.

85-1376

Modal Synthesis of Multiple Substructures with Interface Damping

S.C. Chen, P.R. Millarke

Martin Marietta Corp., Vandenberg AFB, CA

Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 98-100, 1 fig, 1 ref

KEY WORDS: Modal synthesis, Modal truncation, Seismic response, Soil-structure interaction, Damping coefficients

Calculations involving multiple substructures will be investigated in this paper. In the interest of economy, modal truncation is customarily performed on the constrained modes at the substructure level, which introduces inaccuracies into the calculations. The accuracy of the calculations is increased by special attention to the interface degrees of freedom. The concept of interface damping allows control of structural response to excitations which must be transmitted through an interface such as a soil-structure interface in the investigation of seismic response.

85-1377

The Effect of Modal Truncation on Seismic Base Shear

P.R. Millarke

Martin Marietta Corp., Denver, CO

Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 96-97, 2 figs, 2 tables, 4 refs

KEY WORDS: Modal analysis, Seismic response, Base excitation

The truncation of higher frequency mode shapes can result in a loss of accuracy in the calculation of base shear by modal analysis in structures subjected to earthquake loading. Typically, the accuracy of base moment calculations is much better. This situation is investigated by using an example structure.

85-1378

Modal Combination Rules for Multicomponent Earthquake Excitation

W. Smeby, A. Der Kiureghian

Det Norske Veritas, Oslo, Norway

Earthquake Engrg. Struc. Dynam., 13 (1), pp 1-12 (Jan/Feb 1985) 8 figs, 16 refs

KEY WORDS: Seismic excitation, Response spectra

A response spectrum method for dynamic analysis of linear structures subjected to multicomponent seismic input is developed.

85-1379

Microstructural Effects on Wave Propagation in Solids

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Intl. J. Engrg. Sci., 22 (8-10), pp 1181-1186 (1984) 28 refs

KEY WORDS: Wave propagation, Shock waves

Two microstructural phenomena appear important in controlling the evolution of large amplitude stress waves in solids. First is the inherent microstructure of the material which leads to local stress concentration during passage of the wave and influences first order moduli through yielding, fracture, or phase transformation. Second is the evolution of microstructure during stress-wave deformation through heterogeneous yielding and flow.

85-1380

Flowfield Scaling in Sharp Fin-Induced Shock Wave/Turbulent Boundary-Layer Interaction

D.S. Dolling, W.B. McClure

Univ. of Texas, Austin, TX

AIAA J., 23 (2), pp 201-206 (Feb 1985), 9 figs, 17 refs

KEY WORDS: Shock wave-boundary layer interaction

This paper presents the results of an experimental investigation of the three-dimensional interaction of a swept planar shock wave with a turbulent boundary layer. The shock wave was generated by a sharp, unswept fin mounted normal to a flat test surface.

85-1381

Waveform Distortion and Shock Development in Nonlinear Rayleigh Waves

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Univ. of Petroleum and Minerals, Dhahran, Saudi Arabia

Intl. J. Engrg. Sci., 23 (1), pp 113-118 (1985), 3 figs, 2 refs

KEY WORDS: Rayleigh waves, Shock waves, Wave generation

Using an asymptotic theory of nonlinear Rayleigh waves previously developed, numerical solutions are obtained for the variation with distance of the amplitudes of the higher harmonics in an initially sinusoidal wave. The two components of the particle velocity on the free surface are calculated and it is found that after a finite distance a shock develops in the form of a discontinuity in the horizontal velocity component.

VIBRATION EXCITATION

85-1382

Elementary Vibration Response - Two Degree-of-Freedom Model

W.T. Springer

Univ. of Arkansas, Fayetteville, AR 72701

Proc. 1984 SEM Fall Conf. "Computer-Aided Testing and Modal Analysis, Nov. 4-7, Milwaukee, WI, pp 7-11, 6 figs, 2 refs

KEY WORDS: Two degree of freedom systems, Damped structures, Undamped structures, Dynamic vibration absorption (equipment)

The material presented here will be divided into three sections, which involve the two degree of freedom model. First, the behavior of undamped systems is covered. The equations describing both the free and forced vibration response are developed and typical results presented. Second, a similar approach is used to describe the response of damped systems. Third, these concepts are used to design dynamic vibration absorber.

85-1383

Measurement of Unsteady Aerodynamic Pressures

P. Bublitz

European Space Agency, Paris, France

Rept. No. DFVLR-MITT-83-8, ESA-TT-834, 25 pp (May 1984), N84-28757

KEY WORDS: Aerodynamic loads, Flutter, Measurement techniques

User requirements on pressure transducers for measuring unsteady pressures are outlined. Application of the unsteady aerodynamic pressure measuring technique to the flutter and the dynamic response problem is described. It is shown that the requirements set for steady state aerodynamic pressure distribution measurements (such as a high resolution and intensitivity to temperature drifts, overload and accelerations) are particularly necessary in the case of unsteady pressure measurements.

85-1384

Numerical Diffraction by a Uniform Grid

A. Bamberger, J.C. Guillot, P. Joly

Ecole Polytechnique, Palaiseau, France

Rept. No. BNL-tr-1031, 164 pp (1984), DE84012861

KEY WORDS: Wave propagation, Harmonic excitation, Point source excitation

In this report the influence of a spatial discretization on the propagation of a wave generated by a harmonic point source is analyzed. Finite element and finite difference schemes on a uniform grid for the wave equation are used. The asymptotic behavior in space of the elementary solution of the associated Helmholtz equation is studied. We look at the shape of the wave fronts and at the distribution of the amplitude along these fronts.

85-1385

On Some Aspects of Design in Nonlinear Oscillating Systems

R.M. Evan-Iwanowski, G.L. Ostiguy

Syracuse Univ., Syracuse, NY

Polish Solid Mechanics Conf., Proc. 25th, Jachranka, 27-31, Aug 1986. Spon. Inst. of Fundamental Technological Res., Polish Academy of Sciences, p 50

KEY WORDS: Resonant response, Dynamic stability

Significant advances in the field of resonance responses and dynamic stability of nonlinear mechanical systems were made in recent years. To a considerable measure, this was due to the excellent contributions of Polish School of Mechanicians. Presently, a strong trend is developing in the areas of applications and design. To this end, a complete and detailed understanding of the resonance responses and stability conditions is required. Furthermore, they must be oftentimes reassessed in the light of analysis and, particularly, experimentation with life systems. This paper addresses itself to these problems.

85-1386
Even and Odd-Harmonic Solutions of the forced Pendulum Equation (Solutions périodiques paires et harmoniques-impaires de l'équation du pendule forcé)
B.V. Schmitt, N. Sari
Université de Metz, 57000 Metz, Equipe de Recherche associée au C.N.R.S. n° 0399
J. de Mecanique Theor. Appl. 3 (6), pp 979-993 (1984), 10 figs, 11 refs (In French)

KEY WORDS: Pendulums, Harmonic analysis

Initial conditions of even and odd-harmonic solutions of the forced pendulum equation are computed. Their variation in relation with both parameters are given in the form of maps. This paper is the first step in the study of the structure of the equation.

85-1387
Silo as a System of Self-Induced Vibration
J. Kmita
Federal Univ. of Tech., P.M.B. 2373, Makurdi, Nigeria
ASCE J. Struc. Engrg., 111 (1), pp 190-204 (Jan 1985) 13 figs, 11 refs

KEY WORDS: Grain silos, Self-excited vibrations

This paper deals with the experimental investigation of dynamic pressure exerted by a granular material (grit) on the walls of a silo. Experimental set-up with the pressure measuring technique and recorded investigation results are presented. Using dimensional analysis, a formula for the pressure on the walls of a silo is developed in terms of dimensionless parameters. The self-induced vibration theory is used to interpret the experimental results. The general scheme of self-induced vibration systems is examined and a silo with the granular material is identified as one of the self-induced vibration systems.

MECHANICAL PROPERTIES

DAMPING

85-1388
Dynamic Response of Materials in Vibrations
J.D. Rogers
Iowa State Univ., Ames, IA 50011
Proc. 1984 SEM Fall Conf., "Computer-Aided Testing and Modal Analysis," Nov 4-7, Milwaukee, WI, pp 12-17, 7 figs, 12 refs

KEY WORDS: Material damping, Loss factor, Energy dissipation, Dashpots, Beams

Damping is present in all materials and structures. It affects the dynamic response of any vibrating member. This paper presents damping models for some typical engineering materials and provides insight into the effect of the damping on the member's dynamic response. Both linear and non-linear damping models are presented with experimental results from beam specimens used for illustration. The damping is discussed in terms of loss factor, energy dissipation and an equivalent dashpot.

85-1389
Vibration Damping 1984 Workshop Proceedings
L. Rogers
Wright-Patterson Air Force Base, OH 45433
Rept. No. AFWAL-TR-84-3064, 1,002 pp (Nov 1984)

KEY WORDS: Vibration damping, Proceedings

Individual papers of the Vibration Damping Workshop held February 27-29, 1984 in Long Beach, California, are presented. The subjects included: mechanical properties of polymers, experimental methods, damping in metal matrix composites, friction damping, design of damping structure, modal damping values, and applications of damping.

85-1390
Modal Identification of Damped Structures from Response Measurements
H.N. Özgüven, Y. Yaman
Middle East Technical Univ., Ankara, Turkey
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 172-176, 5 figs, 8 refs

KEY WORDS: Modal analysis, Parameter identification techniques, Damping coefficients, Mobility method

A method is developed for the modal identification of structurally damped mechanical components. The modal identification is made from the mobility data measured at certain frequencies. A limited number of modes are identified and the effects of the unidentified modes are included by residual terms. The accuracy of the method is demonstrated by identifying a real test structure. The sensitivity of the method to some parameters is also discussed.

85-1391
On the Damping Ratio Matrix in Multiple Degree of Freedom System
B.L. Jiang, D.J. Inman
Harbin Shipbuilding Engineering Institute, Harbin, Heilongjiang, People's Rep. of China
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 167-171, 7 refs

KEY WORDS: Experimental modal analysis, Critical damping, Multidegree of freedom systems

A commonly used parameter in both experimental and analytical modal analysis is the damping ratio or percent of critical damping. For a single degree of freedom system this concept is clearly defined and knowledge of a system spring constant, mass and damping rate allows the calculation of the damping ratio. In this work this concept is defined for multiple degree of freedom systems. The damping ratio matrix and modal damping ratio matrix are defined in terms of the mass matrix, damping matrix and stiffness matrix for a multiple degree of freedom system of arbitrary dimension.

85-1392
Modal Damping and Sound Power Reduction of Plates with Partial Constrained Layer Damping Treatments
K.K. Stevens, Hong-Yuan Hsu
Florida Atlantic Univ., Boca Raton, FL
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 160-166, 12 figs, 3 tables, 8 refs

KEY WORDS: Modal analysis, Viscoelastic damping, Noise reduction, Rectangular plates

Constrained-layer viscoelastic damping treatments which cover only a portion of the surface area of a vibrating plate can be as effective in controlling vibration levels. Information useful in the design of such damping treatments is presented herein. The effect of the various system parameters on the natural frequencies and modal loss factors for the lower flexural modes of vibration of rectangular plates with partial constrained-layer damping treatments is described. Illustrative results are presented for ranges of the variables commonly encountered in practice.

85-1393
Assessment of the Extent of Nonproportional Viscous Damping
R. Singh, G. Prater, Jr., S.S. Nair
Ohio State Univ., Columbus, OH 43210
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 151-159, 4 figs, 2 tables, 12 refs

KEY WORDS: Modal analysis, Viscous damping

Several numerical indices have been developed recently to examine the extent of non-proportional viscous damping in discrete systems. These indices can provide both quantitative and qualitative indications of the extent of nonproportionality. This paper will discuss the applicability of numerical indices through a multi-degree of freedom damped system example case.

85-1394
The Effect of Damping and Zero Location on Complex Modes
G.D. Shepard, F. Jamil
Univ. of Lowell, Lowell, MA
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 145-150, 3 figs, 1 table, 6 refs

KEY WORDS: Modal analysis, Damping effects, Complex modes

When analyzing a lightly damped structure it is commonly assumed that the mode shapes are real. Recent advances in high resolution instrumentation and system identification techniques have shown, however, that complex modes occur relatively frequently. This paper shows that the mode damping ratio is an unreliable indicator of mode complexity.

FATIGUE

85-1395
The Fatigue Crack Direction and Threshold Behaviour of Mild Steel under Mixed Mode I and III Loading
L.P. Pook
National Engrg. Lab., East Kilbride, Glasgow G75 0QU, UK
Intl. J. Fatigue, 7 (1), pp 21-30 (Jan 1985) 12 figs, 6 tables, 23 refs

KEY WORDS: Fatigue tests, Steel

As part of a program to investigate the mixed mode fatigue crack growth threshold behavior of mild steel, tests were carried out on three-point bend specimens with spark machined initial slits inclined to give mixed Mode I and III displacements. Overall the expected tendency to Mode I crack growth showed as an initial directional discontinuity followed by a smooth rotation of the crack front until it was almost perpendicular to the specimen sides. The crack arrest threshold results and some of the crack growth threshold results could not be analyzed in detail because of lack of appropriate stress intensity factors.

85-1396
Fatigue Life Estimation under Random Loading Using the Energy Criterion
V. Kliman
Inst. of Materials and Machine Mechanics of the Slovak Academy of Sciences, Bratislava, Czechoslovakia
Intl. J. Fatigue, 7 (1), pp 21-30 (Jan 1985) 6 figs, 9 refs

KEY WORDS: Fatigue life, Random excitation, Prediction techniques

A procedure for estimating the useful life of a component for a given probability of fatigue fracture origination under random loading is presented. The method uses material constants obtained from the S/N and cyclic stress/strain curves, standard deviation and probability density distribution of the loading process.

85-1397
Formation of Fatigue Cracks at Holes: Observation and Detection
S. Girshowich, E. Reinberg
Israel Aircraft Industries, Ben Gurion International Airport, Israel

Intl. J. Fatigue, 7 (1), pp 49-54 (Jan 1985) 12 figs, 5 refs

KEY WORDS: Fatigue life, Aluminum, Hole-containing media, Crack propagation

Aluminium specimens with drilled holes were spectrum loaded to observe initiation and growth of very short cracks from 0.1mm deep. A multitude of crack initiation sites located along the bore of the hole was found to be more typical than a single origin. A three-step model of fatigue crack formation at holes is proposed. It is concluded that a crack detected at a hole has a high probability of taking longer to grow to failure than predicted by fracture mechanics analysis.

85-1398

System for Automated Fatigue Crack Growth Testing under Random Loading

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Intl. J. Fatigue 7 (1), pp 3-12 (Jan 1985) 13 figs, 2 tables, 20 refs

KEY WORDS: Fatigue tests, Random excitation

Procedures have been developed for computer-controlled crack propagation testing under random load sequences. They include certain features which are not available in conventional systems. Experimental studies on Al-Cu alloy sheet material point to a requirement for development of standards for spectrum loading crack growth testing.

85-1399

Fatigue and Mean Stress — A Perspective

P. Watson, A. Plumtree

Proc. 1984 SEM Fall Conf., "Computer-Aided Testing and Modal Analysis," Nov 4-7, Milwaukee, WI, pp 102-111, 9 figs, 6 tables, 27 refs

KEY WORDS: Fatigue life, Steel

This paper presents a review of the earliest publications on mean stress in fatigue. It points out the very limited evidence that exists in support of the most commonly used rule, i.e., Goodman's Hypothesis. The early work of Gerber, on the other hand, can still help us today. His Parabolic Rule is based on an attempt to relate mean stress effects to microscopic behavior.

85-1400

Evaluation Procedure for Raw Fatigue Data

S.K. Foss
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Proc. 1984 SEM Fall Conf., "Computer-Aided Testing and Modal Analysis," Nov 4-7, Milwaukee, WI, pp 96-101, 7 figs, 3 refs

KEY WORDS: Fatigue life, Modal analysis

This paper documents an interactive method of analyzing unresolved low cycle fatigue data. It combines the speed of the computer, statistics and good engineering judgment to yield consistent fatigue properties between common material grades.

85-1401

Unique Aspects of Conducting Strength Tests on Thick Composites

C.E. Harris, D.H. Morris
Texas A&M Univ., College Station, TX

Proc. 1984 SEM Fall Conf., "Computer-Aided Testing and Modal Analysis," Nov 4-7, Milwaukee, WI, pp 112-117, 7 figs

KEY WORDS: Composite materials, Fatigue tests, Testing techniques

Conducting fracture tests on thick laminated composites presents some unique test problems. These problems encompass various aspects of loading a specimen to failure as well as performing destructive and nondestructive examinations of load-induced damage. A discussion of these problems is presented along with a description of the experimental methods employed by the authors.

85-1402
Modal Analysis Efficiency Improved Via Strain Frequency Response Functions
C.H. Staker
Bruel & Kjaer Instruments, Inc., Livonia, MI 48150
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 612-617, 11 figs, 2 refs

KEY WORDS: Experimental modal analysis, Fatigue life, Strain frequency response functions

The efficiency of modal analysis is greatly enhanced when fatigue life calculations as well as damaging structural characteristics can be extracted from the acquired data base. Strain frequency response functions are an integral part of this data base and can readily assist the engineer in focusing on the mode of most concern. This paper presents a test procedure inclusive of correlating field, modal, and strain frequency response data. A practical application will be demonstrated from the initial data acquisition to the proposed fix and/or life calculations.

85-1403
An Evaluation of Creep-Fatigue Behavior of 304 Stainless Steel in a Very High Vacuum Environment
M. Morishita, Y. Asada, A. Ishikawa
Power Reactor and Nuclear Fuel Development Corp., 1-13-9 Akasaka Minatoku, Tokyo, Japan
Bull. JSME, 28 (235), pp 7-12 (Jan 1985) 12 figs, 10 refs

KEY WORDS: Fatigue tests, Steel

A series of creep-fatigue tests conducted with 304 stainless steel at 605°C in a very high vacuum environment of 0.1 micropascal were subjected to evaluation based on damage concept relating to an inelastic deformation behavior of the material. In the model, a damage is separated into two components of time-dependent and -independent. Damage components are related to inelastic strain parameters to give damage rate equations in which material constants are determined from experiments.

85-1404
Stochastic Modeling of Fatigue Crack Growth
K. Sobczyk
Institute of Fundamental Technological Research, Polish Academy of Sciences, Warsaw, Poland
Polish Solid Mechanics Conf., Proc. 25th, Jachranka, Aug 27-31, 1984. Spons. by Inst. of Fundamental Technological Res., Polish Academy of Sciences, p 153

KEY WORDS: Fatigue life, Stochastic processes

In the recent years an increasing amount of attention has been devoted to the problems of probabilistic or stochastic modeling of fatigue damage. One of the possible approaches to modeling of random fatigue is randomization of the deterministic experimental laws for fatigue crack growth. The objective of the paper is to go further in developing the randomization methodology of investigation of random fatigue crack growth.

85-1405
The Effect of a Solid Additive on Rolling Fatigue Life
L. Arizmendi, A. Rincon, J.M. Bernardo
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Trib. Intl., 18 (1), pp 17-20 (Feb 1985) 3 figs, 1 table, 14 refs

KEY WORDS: Fatigue life, Lubrication

Behavior of a series of lubricant oils and the effect of a non stoichiometric inorganic compound, as solid extreme pressure additive, on rolling fatigue life are studied. The rolling four-ball accelerated service simulation test proposed by Barwell and Scott is used. The results show, in all tested cases, the remarkable efficacy of this type of additive.

85-1406
First Excursion and Fatigue Failure Probabilities of Randomly Excited Mechanical Systems
C. Lange, H. Friedrich

Akademie der Wissenschaften der DDR, Institut f. Mechanik, Berlin, German Dem. Rep.
Polish Solid Mechanics Conf., Proc. 25th, Jachranka, Aug 27-31, 1984. Spons. by Inst. of Fundamental Technological Res., Polish Academy of Sciences, p 93

KEY WORDS: Fatigue life, Random excitation

With the help of first excursion probabilities of stochastic processes and of fatigue failure probabilities information is obtained on the reliability and safety of randomly excited mechanical systems in engineering and architecture. Wind and earthquake excitations are considered.

85-1407
A Measurement Technique for Determining Dynamic Crack Speeds in Engineering - Materials Experimentation
C.R. Barnes
Battelle Memorial Inst., Columbus, OH
Exptl. Tech., 9 (3), pp 33-37 (Mar 1985) 5 figs, 18 refs

KEY WORDS: Crack propagation, Measurement techniques

For dynamic-crack-speed determination in brittle materials the technique presented herein offers a relatively simple system for the determination of dynamic crack velocities.

ELASTICITY AND PLASTICITY

85-1408
Modal Analysis of a Healing Fractured Long Bone
P.K. Sen, S. Pal
Engineering Services International Private Limited, BC 192, Salt Lake City, Calcutta-700064, India
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 286-290, 3 figs, 15 refs

KEY WORDS: Modal analysis, Bones, Cracked media

The quantitative determination of bone strength to assess the bone condition or state of fracture healing non-invasively is a clinical problem in orthopaedics. The potentialities of vibration analysis in this area were studied by several research groups.

85-1409
A Dynamical Analysis of Elastic Layer
M. Paluch
Institute of Structure Mechanics, Technical University, Cracow, Poland
Polish Solid Mechanics Conf., Proc. 25th, Jachranka, Aug 27-31, 1984. Spons. by Inst. of Fundamental Technological Res., Polish Academy of Sciences, p 124

KEY WORDS: Elastic media

In this paper the problem of vibrations of elastic layer is considered. An arbitrary load acts on the boundary in a continuous or discontinuous way.

EXPERIMENTATION

MEASUREMENT AND ANALYSIS

85-1410
Multiple Shaker Excitation Using Coherent Signals
H.J. Weaver, J.W. Pastrnak
Univ. of California, Lawrence Livermore National Lab., Livermore, CA 94550
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 117-123, 3 figs, 1 table, 3 refs

KEY WORDS: Experimental modal analysis, Multiple shakers, Transfer functions

This paper describes a technique by which multiple shakers can be used to obtain

transfer functions of a structure. This technique differs from those currently being used in that it requires that the input signals to the shakers be coherent with respect to each other rather than stochastically uncorrelated.

85-1411

Multi Shaker Modal Testing Using a Modified Transient Random Excitation

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Northrop Corporation, Aircraft Division, Hawthorne, CA 90250

Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 553-557, 14 figs, 6 refs

KEY WORDS: Experimental modal analysis, Multiple shakers, Random excitation, Transient excitation

Both multi-shaker random and transient random (burst random) modal testing techniques have a proven history of good modal results. Each has its individual disadvantages. This paper presents a modal testing method which incorporates both of these procedures, and introduces a new method of improving the force and response functions. Preliminary test data from this combined method show a considerable improvement over methods currently in use.

85-1412

A Multiple Shaker Stepped Sine Data Acquisition System

M.A. Clifton, D.S. Hanna, J.M. Keller
BBN Labs., Inc., New London, CT 06320

Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 367-371, 4 figs, 1 ref

KEY WORDS: Experimental modal analysis, Multiple shakers, Periodic excitation

A micro-computer based system has been developed which employs multiple shakers and accelerometers to measure the dynamic characteristics of large structures. The method is based upon stepped sine excitation, with each of the shakers operating at a different frequency.

85-1413

Digital Data Acquisition System for Modal Testing

D. Banaszak, R.D. Talmadge
Flight Dynamics Lab., Air Force Wright Aeronautical Labs., Wright-Patterson AFB, OH 45433

Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 108-116, 5 figs, 1 table, 15 refs

KEY WORDS: Experimental modal analysis, Data recorders, Data processing, Aircraft vibration

The Structural Vibration Branch (FIBG) of the Air Force Wright Aeronautical Laboratories conducted a Ground Vibration (Modal) Test (GVT) on a full scale F-16 aircraft. To measure 120 accelerometer signals simultaneously as required by the GVT, FIBG has designed and fabricated in-house a complete data acquisition system to measure and condition all the required transducer signals. This article describes that system.

85-1414

Advanced Measurement Method of Frequency Response Function

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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 565-568, 5 figs, 2 refs

KEY WORDS: Experimental modal analysis, Frequency response function, Fast Fourier transform

This paper discusses a new method of measuring the frequency response function (FRF), using a fast Fourier transform (FFT). It demonstrates the effectiveness of this technique in performing high-speed FRF measurements of high-quality with a

wide dynamic range. Also discussed is a method of performing an FRF measurement with sufficient frequency resolution over all analysis ranges. Finally, the concept of phase unwrapping is briefly described.

85-1415

Angular Vibration Measurements Transducers and Their Configuration

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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 503-506, 4 figs, 1 table, 2 refs

KEY WORDS: Torsional vibrations, Measuring instruments, Vibration transducers

In most systems only linear transducers are used, and the rotational movements are calculated as combinations of the measured linear vibrations. This method will only yield correct results when the structure between the transducers behaves as a rigid body.

85-1416

An Intelligent Amplifier and Its Application to Modal Testing

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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 507-510, 4 figs, 3 refs

KEY WORDS: Experimental modal analysis, Measuring instruments, Amplifiers

In 1967 AFWAL/FIBG sponsored its first development of an automatic gain controlled amplifier (AGC) to solve the problem of recording transducer outputs which have large dynamic ranges. This amplifier has been used very successfully for the past 16 plus years in flight testing as well as ground applications. In February 1982 FIBG initiated an R&D effort with Aydin Vector to take this technology and upgrade it to the state-of-the-art in so far as circuit design, accuracy and packaging concepts. The results of this contract is an Automatic Gain Ranging Amplifier (AGRA) that has excellent performance. The amplifier is in the form of a hybrid and contains not only the AGRA but a 6 pole pre-sample filter that has four programmable ranges. With the use of a second hybrid FIBG has under development, a universal signal conditioner is available to handle almost any type of transducer whether it is self generating or non-self generating.

85-1417

Instrumentation System for Monitoring Forces and Motions on Articulated Vehicles. Final Report

C.B. Vallone, A.S. Baum, R.S. Rice, F.J. Lukowski
Calspan Corp., Buffalo, NY
Rept. No. FHWA/RD-83/038, 140 pp (July 1983) PB 84-231091

KEY WORDS: Measuring instruments, Articulated vehicles, Force measurement

In order to monitor the forces and motions to which an articulated vehicle is subjected, a field data acquisition and reduction system has been designed. The on-board data acquisition unit is built around an RCA-1802 microprocessor and an Archive Sidewinder streaming cartridge tape drive. Data is presented to the tape unit through use of the microprocessor's direct memory access (DMA) capability. Circuit diagrams of the instrumentation system's major components have been included as well as a description of operational procedures.

85-1418

Instrumentation System for Monitoring Forces and Motions on Articulated Vehicles. Operators Manual

C.B. Vallone, A.S. Baum, R.S. Rice, F.J. Lukowski
Calspan Corp., Buffalo, NY
Rept. No. FHWA/RD-83-39, 53 pp (July 1983) PB84-231109

KEY WORDS: Measuring instruments, Articulated vehicles, Force measurement

In order to monitor the forces and motions to which an articulated vehicle is subjected, a field data acquisition and reduction system has been designed. The user operational procedures for a unit to monitor forces and motions of articulated vehicles, along with the details for interfacing with the data reduction software are contained in this document.

85-1419
Gravimetric Calibration
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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 548-552, 5 figs, 5 refs

KEY WORDS: Experimental modal analysis, Calibrating, Measuring instrumentation, Transducers

Gravimetric calibration is an effective method of determining the absolute calibration of motion sensors. It provides the calibration in both magnitude and phase as a function of frequency and extends the typical calibration range to less than 1 Hz and greater than 30,000 Hz.

85-1420
Structural Dynamic Measurements Using Intensity Methods
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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 558-564, 16 figs, 3 refs

KEY WORDS: Experimental modal analysis, Acoustic intensity method, Measurement techniques

The analysis of the dynamic behavior of structures may be carried out as a theoretical approximation using finite element methods. In practice, no excitation takes place without an energy supply, and damping is realized through the absorption of energy. The measurement of energy flow may therefore give important information about structural behavior both linear and nonlinear. The information may often be best obtained using the "natural" excitation energy, but also the application of energy in selected points may be useful for a dynamic study. Measurements may be carried out using acceleration or velocity of the surface.

85-1421
Comparison of Acoustic and Mechanical Excitation for Modal Response Measurements
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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 124-130, 15 figs, 1 table, 1 ref

KEY WORDS: Experimental modal analysis, Acoustic excitation, Impact hammer tests

An acoustic field is examined as an alternate to mechanical excitation of a test specimen to measure modal response. A square, flat plate with clamped edges is used because classical analytical solutions to its modal analysis are readily available. A small hammer with a built-in force transducer is used to mechanically excite the plate, and the plate is excited with electro-pneumatic acoustic drivers coupled to a progressive-wave test fixture. Conclusions are presented concerning the equivalence of acoustic and mechanical excitation for obtaining modal response.

85-1422
Dynamic Analysis of a Rotating Anode X-Ray Vacuum Tube
J.W. Herrick, J.R. Annis, D.A. Nickel
Proc. 1984 SEM Fall Conf., "Computer-Aided Testing and Modal Analysis, Nov 4-7, Milwaukee, WI, pp 91-95, 2 figs, 2 refs

KEY WORDS: Rotating structures, Tubes, Experimental modal analysis, Impact hammer tests, Finite element technique

A key component in many types of medical diagnostic imaging equipment is the X-Ray tube, a device which produces a precisely focused beam of radiation. The characterize the free vibration of the X-Ray tube structure, an experimental modal analysis was performed using impact hammer excitation and standard multi-degree of freedom curve fitting techniques. A finite element model of the rotating anode X-Ray tube was developed concurrently to serve as a design tool. With this finite element model, excellent correlation was obtained with experimental model analysis.

85-1423

Use of the Microphone and Impact Hammer Windowing in Modal Testing

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Proc. 1984 SEM Fall Conf., "Computer-Aided Testing and Modal Analysis," Nov 4-7, Milwaukee, WI, pp 55-60, 8 figs, 4 tables, 6 refs

KEY WORDS: Experimental modal analysis, Impact hammer tests, Microphone technique

Experimental results are presented indicating that a microphone can produce structural response time histories which are quite satisfactory for modal analysis. Impact excitation data from two simple, relatively light structural elements confirm that natural frequencies and mode shapes may be determined more accurately by acoustic measurement than by use of an accelerometer. The reason for the improvement with microphone use is likely due to the inertial loading of the accelerometer.

85-1424

Analysis of Experimental Complex Modes

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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 223-230, 8 figs, 7 refs

KEY WORDS: Complex modes, Structural modification techniques, Electronic instrumentation, Modal analysis, Case histories

It has become necessary to understand and to predict the cause of complex modes. A physical interpretation of the effects of design modifications on the mode shapes is obtained.

85-1425

Determination of Rotational Degrees of Freedom for Moment Transfers in Structural Modifications

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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 465-470, 2 figs, 1 table, 10 refs

KEY WORDS: Modal analysis, Structural modification techniques, Rotational degrees of freedom, Beams

Structural modification procedures using beam or plate elements require the inclusion of the rotational degrees of freedom (Rdof) at structure attachment positions to effect moment transfers. Estimation of the rotary effects has to be determined to properly perform a modification procedure if the Rdof are not available in a structural model. This paper presents several methods of generating the desired Rdof from the existing translational dof (Tdof) in the original model. All the methods involve an expansion process associated with dynamic or static condensation procedures. Shape functions, similar to those employed in finite element methods (FEM), also are used to determine the local geometric interpolations needed for the estimation of Rdof. A beam structure is used to evaluate the different methods under various modeling conditions.

85-1426

Structural Dynamics Modification via Sensitivity Analysis

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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 483-489, 4 figs, 6 refs

KEY WORDS: Modal analysis, Structural modification techniques, Sensitivity analysis, Frequency response function

A structural dynamics modification scheme without "trial and error" approach is developed in this paper. The sensitivities of natural frequencies and mode shapes with respect to mass and stiffness coefficients of structures are used to calculate the quantities of modification and predict the new dynamic characteristics.

85-1427
Realistic Structural Modifications: Part I. Theoretical Development
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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 471-476, 4 figs, 18 refs

KEY WORDS: Modal analysis, Structural modification techniques, Rotatory inertia effects, Shear deformation effects

This paper presents the basic theory that will make available the vast library of transfer matrix structural element models to the experimental structural modal analysis process. Full implementation of this method will allow realistic structural changes to be made to the experimental mathematical models developed through experimental modal analysis.

85-1428
Modal Testing and Analysis of Nova Laser Structures
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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 431-435, 6 figs, 1 table, 3 refs

KEY WORDS: Experimental modal analysis, Laser structures, Seismic response, Vibration response, Case histories

The NOVA system consists of several large steel framed structures. In conjunction with design engineers, the tower was first modeled and analyzed by sophisticated finite element techniques. A modal test was then conducted on the tower structure to evaluate its vibrational characteristics and seismic integrity as well as for general comparison to the finite element results. This paper will discuss the procedure used in the experimental modal analysis and the results obtained from that test.

85-1429
Experimental Aspects of Nelson's Principle Applied to the Modal Analysis of Non-Linear Structures
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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 436-440, 8 figs, 12 refs

KEY WORDS: Experimental modal analysis, Nonlinear systems, Nelson principle, Periodic excitation, Random excitation

Modal analysis is one of the most common methods used to determine a mathematical model of an existing structure. If non-linearities are noticeable in the measured data or exist but are not readily identifiable, Lord Nelson's principle is often involved. A blind eye is turned to the nonlinearities. This paper presents the results of an experimental study in which a nonlinear structure is tested at various amplitudes. The results from the transient test are used to establish an empirical guide to the validity in applying linear modal analysis modeling for impulse response predictions.

85-1430
A New Method of Complex Modal Parameters Identification with Application

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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 372-378, 3 figs, 1 table, 6 refs

KEY WORDS: Experimental modal analysis, Parameter identification technique, Complex modes, Periodic excitation

A new technique that can be used to determine the structural complex modal parameters by multiple sinusoidal excitation test is presented. The method is applicable to the classical multiple excitation and single point excitation conditions. It is applicable to arbitrary point excitation condition that the number of the exciting forces is not equal to that of the degrees-of-freedom of the structure.

85-1431
Measurement of Dynamic Characteristics of a Structure Using Programmed Sine Step Test
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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 338-345, 9 figs, 5 refs

KEY WORDS: Experimental modal analysis, Computer programs

This paper reviews the development and testing of a microcomputer based software system STEP-SINE (Stepped Sine Test system) for measuring and real-time plotting of dynamic characteristics such as compliance, mobility, accelerance. It can be used to extract the resonance frequency and modal loss factor information from the measured data. The STEPSINE measurement procedure consists of applying a pure sine excitation to the structure in specified frequency steps, measuring the applied force and response after specified dwell time and plotting the variation of compliance and mobility with frequency in real-time. It also has an additional "seek resonance" facility by which the frequency resolution can be increased at identified resonance peaks.

85-1432
Modal Parameter Identification from Multi-Point Measured Data
Hou Zhiqiang, Cheng Yaodong, Tong Zhongfang, Sun Yueming
Zhejiang Univ., Hangzhou, China
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 138-144, 2 figs, 1 table, 1 ref

KEY WORDS: Experimental modal analysis, Parameter identification technique, Multipoint excitation technique, Curve fitting

A method of curve fitting is proposed to assure that natural frequency and modal damping ratio of every order of a vibrating system identified from many sets of response data measured at different points are identical in the least-squares sense.

85-1433
Global Curve Fitting of Frequency Response Measurements Using the Rational Fraction Polynomial Method
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Structural Measurement Systems, San Jose, California
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 390-397, 8 figs, 4 refs

KEY WORDS: Modal analysis, Global fitting method, Curve fitting, Frequency response function

The latest generation of FFT analyzers contains still more more and better features for excitation, measurement and recording of frequency response functions (FRF's) from mechanical structures. As measurement quality continues to improve, a larger variety of curve fitting methods are being developed to handle a set of FRF measurements in a global fashion. In this paper, a new formulation of the Rational Fraction Polynomial method is given which can globally curve fit a set of FRF meas-

urements. The pros and cons of this approach are discussed.

85-1434

A Frequency Domain Curve Fitting Algorithm with Improved Accuracy

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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 541-547, 8 figs, 5 refs

KEY WORDS: Modal analysis, Frequency domain method, Curve fitting

A problem has been identified in curve fitting algorithms which leads to biased estimates of pole locations. The source of the error has been found and the bias corrected. A weighting function is also introduced which significantly increases the curve fitter's ability to fit small peaks. Additional techniques have been developed which reduce the time required to fit frequency responses, and which further improve the quality of the fit.

85-1435

Taking Non Linearities into Account in Modal Analysis by Curve Fitting of Transfer Functions

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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 88-95, 15 figs, 2 tables, 4 refs

KEY WORDS: Modal analysis, Curve fitting

In classical modal extraction methods, small nonlinearities in the structures induce large errors in the estimation of dampings and generalized masses. To minimize these errors, it is proposed to introduce nonlinear complementary terms in a curve fitting technique of transfer functions.

85-1436

Simultaneous Vector Iteration for the Eigensolution of Nonconservative System Dynamics

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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 515-522, 21 refs

KEY WORDS: Modal analysis, Eigenvalue problems

In the analysis of mechanical system dynamics, the linear algebraic eigenvalue problem plays a key role in providing engineering insight into the characteristic behavior of complicated systems. Moreover, decomposition strategies using eigensolution results permit efficient calculation of system response to external excitation. This paper focuses on various aspects associated with the general eigenvalue problem for nonhermitian systems of large order. Certain solutions which can be obtained without iteration are discussed.

85-1437

The Extraction of Valid Residue Terms Using the Polyreference Technique

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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 80-87, 12 figs, 7 tables, 12 refs

KEY WORDS: Modal analysis, Data processing, Polyreference method, Frequency domain method

The polyreference complex exponential algorithm uses frequency response data from multiple input locations in a global least squares fashion. This algorithm uses the impulse response functions obtained by inverse Fourier transforming the measured frequency response functions into the time domain. This paper presents the theory for the frequency domain formulation and demonstrate its applicability with a few simple test cases.

85-1438
A Modal Confidence Factor for the Polyreference Method
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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol I, pp 305-310, 3 figs, 4 tables, 7 refs

KEY WORDS: Modal analysis, Polyreference method, Modal extraction method

This paper describes a modal confidence factor that lets the user of the polyreference modal extraction method distinguish between physical and computational modes.

85-1439
Elementary Vibration Response — The Single-Degree-of-Freedom Model
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Virginia Polytechnic Inst. and State Univ., Blacksburg, VA 24061
Proc. 1984 SEM Fall Conf., "Computer-Aided Testing and Modal Analysis," Nov 4-7, Milwaukee, WI, pp 1-6, 4 figs, 5 refs

KEY WORDS: Experimental modal analysis, Frequency response, Forced vibration, Mobility method, Impulse response

This paper will cover the response of single-degree-of-freedom dynamic systems. The approach will connect the mathematical model to the real-world physical model while giving insight in the application to basic modal analysis concepts. Subjects of frequency response, mobility, impulse response, and forced response will be presented in light of their relationship to experimental modal analysis.

85-1440
The Error Bound of the Finite Dynamic Element
Zhao Lingcheng, Chen Jingyu
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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 249-254, 8 figs, 3 refs

KEY WORDS: Modal analysis, Finite element technique, Error analysis

In the present paper a formula is derived by a mathematical procedure without relying upon Guyan reduction. According to this procedure, explicit expressions of shape function vector and impedance matrix can be found. Numerical examples for bar, beam and membrane show that the error bound formula is applicable for most cases.

85-1441
Using the Hilbert Transform with Linear and Nonlinear Multi-Mode Systems
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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 255-263, 9 figs, 6 refs

KEY WORDS: Modal analysis, Hilbert transforms

This paper describes the use of the Hilbert transform with multi-mode linear and nonlinear systems. It is shown that due to truncation of the frequency response data, correction terms are necessary when computing the Hilbert transform.

85-1442
A Comparison of H_1, H_2, and H_v Frequency Response Functions
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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 272-278, 9 figs, 5 tables, 5 refs

KEY WORDS: Frequency response functions, Modal analysis

Recently, several new ways of estimating frequency response functions (FRF s) from auto and cross spectra have been discussed in the literature. Of these methods, the most notable may be H_2, which improved estimation accuracy near resonances, and

H_v, that employs a tensorial (geometric) approach for uniformly robust estimation. Like the traditional estimator, H_1, but unlike H_2, H_v may also be defined for multiple input - multiple output systems. This study presents a comparison between the performance of these methods over a range of excitation techniques and structure types.

85-1443
A New Method of Component Modal Synthesis with High Accuracy Computational Efficiency Synthesis Flexibility and Adaptability
You-fang Lu, Zen-tong Ma
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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 291-298, 1 fig, 1 table, 8 refs

KEY WORDS: Modal analysis, Component mode synthesis

Based on the requirements of static completeness of Ritz basis, vectors of a substructure, a new method of component modal synthesis is presented.

85-1444
A Solution to the Craig/Bampton Eigenvalue Problem for Multi-Component Structures
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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 299-304, 1 fig, 7 refs

KEY WORDS: Modal analysis, Component mode synthesis

A cost-effective technique is presented to solve the system eigenvalue problem associated with the Craig/Bampton component mode synthesis method. Supspace iteration is employed in order to take advantage of the special form of this eigenvalue problem.

85-1445
A New Approach to Vibratory Systems Based on the Method of Dimensional Analysis
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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 329-337, 2 figs, 9 tables, 14 refs

KEY WORDS: Modal analysis, Dimensional analysis, Beams, Single degree of freedom systems

The paper presents the application of dimensional analysis to vibratory systems. The aim of examples given is to determine the natural frequencies of the systems utilizing dimensional analysis.

85-1446
Structural Modal Analysis under Random External and Parametric Excitations
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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 360-366, 6 figs, 7 refs

KEY WORDS: Modal analysis, Random excitation, Parametric excitation, Two-degree of freedom systems

The normal mode interaction of a two degree-of-freedom structural system subjected to random external and parametric excitations is investigated. The analysis is confined to the linear dynamic coupling for which the normal mode frequencies and mode shapes are obtained in terms of the system parameters.

85-1447
The Principle and Application of Vibration Time Domain Monitoring Technique
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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 379-383, 9 refs

KEY WORDS: Modal analysis, Random decrement technique, Correlation technique, Statistical analysis

From the viewpoint of system analysis and statistical methods, the principle of random decrement technique is analyzed. The feasibility of estimating the free response and the modal parameters of a linear system under certain conditions by random decrement technique is discussed.

In this paper relationships among the randomdec signature, the free decaying curve and the auto-correlation function are expounded. The analytical expressions of randomdec signature of multi-degree-of-freedom systems in the condition of real mode and complex mode are derived. A simple calculating method of modal parameters obtaining from the randomdec signature is presented.

85-1448

Reanalysis Techniques Used to Improve Local Uncertainties in Modal Analysis

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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 398-402, 1 fig, 2 tables, 10 refs

KEY WORDS: Modal analysis, Natural frequencies, Correlation technique, Data processing

Methods of improving the frequency correlation of a finite element model which contains localized uncertainties are studied in this paper. With the proposed methods, uncertain parameters in the original model are adjusted to improve the correlation between measured and predicted natural frequencies. Two approaches, one yielding an exact solution, one an approximate solution, can be applied; both methods are based on reanalysis formulations.

85-1449

Randomdec Analysis of Multi-Degree-of-Freedom Systems

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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 101-107, 5 refs

KEY WORDS: Modal analysis, Random decrement technique, Multidegree of freedom system

85-1450

On Antiresonances, with Application to Control of Structures

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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 523-526, 4 figs, 2 refs

KEY WORDS: Modal analysis, Antiresonant analysis

Much of the field of modal analysis is focused on the determination of the transfer function poles (eigenvalues) of a structural dynamic system and the corresponding modes (eigenvectors). These eigenparameters are of practical importance since they characterize the resonant response of a structure to external forcing or to nonzero initial conditions. In contrast, the determination of the transfer function zeros has not received much interest. This paper shows that the determination of the zeros and the corresponding modes can be formulated as an eigenvalue problem, similar to ordinary modal analysis, and that the resulting eigenparameters characterize the antiresonant response of the structure.

85-1451

The Random Response Calculations of Linear Multi-Degree of Freedom System Using Matrix Reduction Technique

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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 527-535, 3 figs, 3 tables, 5 refs

KEY WORDS: Modal analysis, Response spectral density, Random response, Multidegree of freedom systems, Matrix reduction methods

A new approach for the calculation of response spectral density for a linear stationary random multidegree of freedom system is presented. This method is based on condensing the system matrices and introducing a set of auxiliary variables. The response spectral density matrix obtained by using this new approach contains the spectral densities and the cross-spectral densities of the master degrees of freedom chosen.

85-1452
Elementary Digital Frequency Analysis
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Proc. 1984 SEM Fall Conf., "Computer-Aided Testing and Modal Analysis," Nov 4-7, Milwaukee, WI, pp 18-24, 7 figs, 4 refs

KEY WORDS: Frequency response functions, Digital techniques

Digital frequency analysis is typically accomplished through the use of a Fast Fourier Transform (FFT) algorithm of some form. A numerical estimate of the Fourier series coefficients for a finite length sample of an actual signal is obtained by treating the sample as though it had been taken from a deterministic signal. Examples of results for various deterministic and random signals are presented and compared to theoretical predictions.

85-1453
Modal Analysis by State-Space Approach in Frequency Domain
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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 403-409, 2 figs, 28 refs

KEY WORDS: Modal analysis, State space approach, Frequency domain method, Data processing

This paper tests a new procedure to identify the eigenvalue problem matrix "A" and thus the system's modal parameters, by utilizing the frequency response of the system in state-space. A sample identification test is performed with added random error in order to simulate real measuring conditions.

85-1454
Identification of Mechanical System Modal Parameters Using Time Series Approach
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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 536-540, 8 figs, 2 tables, 2 refs

KEY WORDS: Modal analysis, Time series analysis method, Fast Fourier transform, Maximum entropy spectral analysis

The principles and application of FFT spectral analysis method and maximum entropy spectral analysis method on estimating mechanical system modal parameters are described in this paper. By means of microcomputer, the FFT spectrum, AR model and maximum entropy spectrum of mechanical vibration signals with different numbers of sample data are obtained. The results of experiments and analysis show that the maximum entropy spectrum has an advantage over the FFT spectrum.

85-1455
Use of Non-Contact Measurements for Modal Analysis of Disk Drive Components
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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 490-496, 24 figs, 1 table, 7 refs

KEY WORDS: Modal analysis, Computer storage devices, Proximity probes

Modal analysis of some very light components used in computer disk drives necessi-

tates using noncontact measurements. This paper presents results of such an analysis on a gimbal spring design considered for a modern drive. The results are compared to those determined from a finite element analysis.

ting frequency resolution to bias error. Graphs relating to anti-aliasing filter slopes to amplitude attenuation, and graphs relating confidence levels in estimating the true mean square, auto spectra, and transfer function to the frequency resolution and total time record of test data analyzed are given.

85-1456

Indirect Identification of Excitation Forces by Modal Coordinate Transformation

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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 685-690, 7 figs, 6 refs

KEY WORDS: Modal analysis, Force measurement

The application limits of the modal coordinate transformation method are presented using some analytical examples. The method has been applied on a frame substructure identification problem to illustrate the practical implementation of the technique.

85-1457

Guidelines for the Reduction of Random Modal Test Data

M.K. Au-Yang, K.P. Maynard
Babcock & Wilcox, Utility Power Generation Div., P.O. Box 1260, Lynchburg, VA 24505

Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 384-389, 6 figs, 4 refs

KEY WORDS: Modal analysis, Random excitation, Experimental data, Data processing

Based on the assumption that the test data are stationary, random, and follow a Gaussian probability distribution, guidelines for choosing the sampling rate, frequency resolution, number of ensemble averages, block size, filter cut-off point, and total time record to be analyzed are presented. Also included in the paper are expressions equa-

85-1458

Modal Analysis Using Dynamic Stiffness Data

B.J. Dobson
Royal Naval Engineering College, Manadon, Plymouth, Devon

Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 279-285, 15 figs, 9 refs

KEY WORDS: Modal analysis, Parameter identification techniques, Dynamic stiffness

A method for extracting modal parameters; natural frequency, mode shape and loss factor, using dynamic stiffness (excitation/-response) data is described. The technique is compared with the use of Nyquist plots for the analysis of receptance (response/-excitation) data. It is shown that dynamic stiffness analysis requires fewer experimental points, is less affected by noise and can be used as a qualitative guide in assessing the data. The technique is illustrated using a model eleven degrees of freedom system and a large cylindrical structure.

85-1459

Analysis of Transient Strain Gage Signals Using an FFT Computer Algorithm

J.F. Doyle
Purdue Univ., West Lafayette, IN 47907

Proc. 1984 SEM Fall Conf., "Computer-Aided Testing and Modal Analysis," Nov 4-7, Milwaukee, WI, pp 38-44, 11 figs, 5 refs

KEY WORDS: Spectral analysis, Fast Fourier transforms

This paper is concerned with data manipulation, e.g., computations on the original

data. This approach allows more sophisticated and faster data processing to be performed than can be obtained from the small stand alone computer in the laboratory. Further, these larger systems usually support a variety of analysis packages such as nonlinear system solvers or complex variables that make programming a much easier job.

85-1460
Modal Analysis of a Violin
K.D. Marshall
BFGoodrich Res. and Dev. Ctr., Brecksville, OH 44141
J. Acoust. Soc. Amer., 77 (2), pp 695-709 (Feb 1985) 11 figs, 2 tables, 21 refs

KEY WORDS: Violins, Modal analysis

The vibrational behavior of a violin is studied using modal analysis techniques. The violin was considered to be an input-output system, and impact testing was used to measure the frequency response functions for the instrument over the frequency range of 0-1300 Hz. Both the input force and the response acceleration were recorded and analyzed. The results provide a complete modal data base for this violin, information which may be used to characterize the instrument in subsequent analytical studies. It was concluded that the violin, exclusive of the strings, can be modeled as a linear second-order system, and its vibrational behavior can be expressed as a summation of real normal modes.

85-1461
On Smoothing and Separating Local Values of Multiple Modes from Incomplete Set of Mobility Measurement Data (Lissage et séparation de modes multiples à partir de mesures incomplètes de mobilité)
J.C. Michon
Laboratoire de Mécanique des Structures, E.N.S.M. (École Nationale Supérieure de Mécanique), 1, rue de la Noë, 44072 Nantes Cedex
J. de Mecanique Theor. Appl., 3 (5), pp 787-804 (1984) 1 fig, 2 tables, 15 refs (In French)

KEY WORDS: Mobility methods

This paper is concerned with local value determination of the modes of a structure from results of experimental mobility curves exploitation. The work is done in the most general case when multiple modes exist. These modes are formed on the damped structure.

85-1462
Global Experimental Modal Analysis, A Comparison of Different Methods
L.L. Carrascosa, J.M. Busturia, J.G. Gimenez
Centro de Estudios e Investigaciones Tecnicas de Guipúzcoa, Barrio Ibaeta S/N, 20009 San Sebastián, Spain
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 311-321, 10 figs, 12 refs

KEY WORDS: Experimental modal analysis, Computer programs

A comparison of the methods of Global Prony, Global Ibrahim Time Domain, Global Rational Fraction Polynomials, and Global Nonlinear Least-squares is presented.

85-1463
New Method of Determining the Eigensolutions of the Associated Conservative Structure from the Identified Eigensolutions
Qiang Zhang, G. Lallement
Laboratoire de Mecanique Appliquée, Associé au C.N.R.S., Faculté des Sciences -La Bouloie - Route de Gray - 25030 Besancon Cedex, France
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 322-328, 1 fig, 4 tables, 9 refs

KEY WORDS: Numerical methods, Eigenvalue problems, Modal analysis

This study deals with the numerical determination of real eigenvalues and eigenvec-

tors of the associated conservative structure from identified complex eigenvalues and eigenvectors.

85-1464

Dynamic Analysis of an Elevator Counterweight Systems

Horn-Sen Tzou
North Carolina A&T State Univ., Greensboro, NC

Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 231-236, 7 figs, 4 tables, 9 refs

KEY WORDS: Elevators, Earthquake response, Finite element technique, Modal analysis, Case histories

The vulnerability of elevator systems has been demonstrated from recent earthquake reports. In this study, a finite element model representing a full-scale elevator counterweight systems is constructed by using beam elements. The dynamic behavior of the counterweights/frame and guide rails is evaluated in the dynamic analysis using direct integration method.

85-1465

Modal Analysis Using Dynamic Condensation Method

M. Paz
Univ. of Louisville, Louisville, KY

Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 242-248, 1 fig, 4 tables, 15 refs

KEY WORDS: Modal analysis, Modal superposition methods, Dynamic condensation method

This paper presents the dynamic analysis of some simple structures by modal superposition using the dynamic condensation method. The application of this method reduces the corresponding eigenproblem and produces results virtually exact for all the modes of the reduced system.

85-1466

System Prediction Using Damped Component Modes

K.F. Martin, K.H. Ghlaim
Univ. of Wales Inst. of Science and Technology, Cardiff, UK

IMechE, Proc., 198 (16), pp 261-268 (1984) 3 figs, 8 tables, 10 refs

KEY WORDS: Eigenvalue problems, Substructuring methods, Damped modes, Matrix methods, System identification techniques

This paper describes a method of predicting the vibrational characteristics of a system when the components, which have mass, stiffness and damping, are connected together by connections which are characterized by stiffness and damping. A matrix set involving the complex eigenvalues and eigenvectors of the components together with a connection matrix is solved to give system eigenvalues and eigenvectors. The application of this method to a particular system is shown to produce the same results as those obtained for the unsubstructured system.

85-1467

An Investigation of the Time History and Modal Responses of Some Simple Linear and Nonlinear Systems

N.F. Hunter, Jr.
Los Alamos National Laboratory, Los Alamos, New Mexico

Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 410-418, 19 figs, 2 refs

KEY WORDS: Modal analysis, Nonlinear systems, Time domain method, Frequency domain method, Numerical methods

This paper describes the results obtained from the numerical analysis of some simple (one to four degrees of freedom) linear and nonlinear systems. The systems are excited by force or acceleration impulsive loading and the acceleration responses are observed in both the time and frequency domains. The types of nonlinearities include gaps or dead zones, bilinear springs, and hysteretic springs or sliding joints.

85-1468
Present-Day Problems in Identification of Dynamic Systems: A Review
J. Wicher
Polish Academy of Sciences, Warsaw, Poland
Rept. No. ISSN-208-5658, 35 pp (1984)
N84-29555

KEY WORDS: System identification techniques, Reviews

The problem connected with identification procedures which can be treated as a step in model building theory are examined. The concepts of parameter identification, computational techniques for nonlinear systems, and output error in the construction of a model are investigated.

85-1469
On the Parameter Identification of Elastomechanical Systems Using Input and Output Residuals
N. Cottin, H.P. Felgenhauer, H.G. Natke
Curt-Risch-Institut f. Dynamik, Schall- und Messtechnik, Universitat Hannover, Callinstr. 32, D-3000 Hannover 1, Fed. Rep. Germany
Ing. Arch., 54 (5), pp 378-387 (1984) 3 figs, 3 tables, 8 refs

KEY WORDS: Parameter identification technique, Least squares method

The dynamic behavior of elastomechanical systems may be described by a structured mathematical model, the computational model. The computational model is erroneous. It can be improved by test results, assuming that they reflect the real dynamic behavior of the system under test. The correction or improvement of the computational model by measured quantities has to take into account the random measurement errors, which means that parameter estimation methods have to be applied.

85-1470
Parameter Estimations of Dynamic Systems by Means of the Principle of Minimal Excitation Energy
W. Wedig
Universitat Karlsruhe, Institut f. Technische Mechanik, Kaiserstrasse 12, D-7500 Karlsruhe, Fed. Rep. Germany
Ing. Arch., 54 (5), pp 388-399 (1984) 8 figs, 8 refs (In German)

KEY WORDS: Parameter identification technique

The Maximum Likelihood (ML) method gives the most effective algorithms for problems of parameter estimation and system identification. It is shown that the known ML-estimators are derivable by means of the principle of minimal excitation energy in stochastic systems. They can be extended to more general estimation problems.

85-1471
Modal Vector Estimation for Closely-Spaced-Frequency Modes
R.R. Craig, Jr., Yung-Tseng Chung, M.A. Blair
Univ. of Texas at Austin, Austin, TX 78712
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 672-678, 7 figs, 16 refs

KEY WORDS: Modal analysis, Parameter identification technique

Identification of modal parameters is made more difficult if the system has repeated frequencies or even closely spaced frequencies. This paper discusses the problems associated with closely-spaced-frequency modes and describes two related methods for dealing with these problems.

85-1472
Parameter Estimation in a Constrained State Space
K.F. Gong, A.A. Magliaro, S.C. Nardone
Naval Underwater Systems Ctr., Newport, RI
Rept. No. NUSC-6286, 10 pp (June 1984)
AD-A144 035

KEY WORDS: Parameter identification techniques, Acoustic excitation

This paper examines the problems of state estimation for a moving acoustic source confined to a well-defined, simply-connected or multiply-connected region of state space. A multiple-parameter constrained estimator that provides enhanced performance and that permits determination of the most probable solution is presented. The estimator is a batch processor that yields both dynamic and residual classifiers, the behavior of which is shown to be dependent on source-observer geometry. The proposed realization is well-suited for solution selection through hypothesis testing. Experimental results showing estimator performance are presented and solution quality is discussed.

DYNAMIC TESTS

85-1473

Computer-Aided Dynamic Testing of Composite Materials

S.A. Suarez, R.F. Gibson
Univ. of Idaho, Moscow, ID 83843

Proc. 1984 SEM Fall Conf., "Computer-Aided Testing and Modal Analysis," Nov 4-7, Milwaukee, WI, pp 118-123, 11 figs, 2 tables, 12 refs

KEY WORDS: Composite materials, Impact hammer tests, Fast Fourier transforms, Experimental modal analysis

The dynamic mechanical properties of composite material specimens are found by using a new computer-aided impulse technique. Small beam specimens are excited in either flexural or extensional vibration by an electromagnetic hammer with a force transducer in its tip, while specimen response is measured with an eddy current probe or accelerometer. A desktop computer/fast Fourier transform analyzer system is then used for rapid data acquisition and computation of the complex modulus by the half-power bandwidth method.

85-1474

Prediction of Resonance Frequencies for Ventilated Wall Wind Tunnels

M. Mokry
National Aeronautical Establishment, Ottawa, Ontario, Canada

"Wind Tunnels and Testing Techniques," pp 15-1 - 15-10, (Feb 1984) (AD-A143 674) AD-P003 768

KEY WORDS: Wind tunnels, Resonant frequencies, Prediction techniques

Based on the reflection and refraction of plane acoustic waves at an interface between the moving stream and the stagnant plenum air, a simple theory is developed for ventilated walls. The intensity and frequency of resonance are determined from the modulus and the argument of the wall reflection coefficient respectively. In contrast to the eigenvalue method, the present technique is capable of predicting partial resonance, occurring in perforated walls and also in slotted walls at Mach numbers below 0.618, for which the resonant waves are partly reflected and partly transmitted at the wall.

85-1475

Recent Developments and Future Directions in Dynamic Stability Research at NAE, Ottawa

K.J. Orlik-Ruckemann, E.S. Hanff, M.E. Beyers
National Aeronautical Establishment, Ottawa, Ontario, Canada

"Wind Tunnels and Testing Techniques," pp 17-1 - 17-6 (Feb 1984) (AD-A143 674) AD-P003 770

KEY WORDS: Test facilities, Aerodynamic loads

Recent research developments at the Unsteady Aerodynamics Laboratory of the NAE include design and construction of several new oscillatory apparatuses and conceptual studies of some additional ones. A method to account for sting oscillation effects on direct derivatives measured in a pitch oscillation experiment is briefly described, and some representative oscillato-

ry results recently obtained on the so called Standard Dynamics Model are discussed.

85-1476
Aeroacoustic Noise Measurements in Wind Tunnel
H.N. Alemdaroglu
Middle East Technical Univ., Ankara, Turkey
"Wind Tunnels and Testing Techniques,", pp 19-1 - 19-14 (Feb 1984) (AD-A143 674) AD-P003 772

KEY WORDS: Wind tunnel testing, Noise measurement

The paper describes the general characteristics of the lowspeed Acoustic Research Wind Tunnel constructed in the Aerodynamics Laboratory of E.N.S.M.A. (Poitiers/-France) and presents results of preliminary type. It has a test section of 30x30 sq cm and a mean velocity of 42 m/s. Aerodynamic measurements revealed a maximum turbulence intensity of less than 1%. The open test section is completely enclosed within an acoustically lined semi-anechoic chamber of dimensions 3.3 x 4 x 2.8 cu m.

85-1477
Fluid Dynamic Aspects of Turbine Engine Testing
J.G. Mitchell
Arnold Engrg. Dev. Ctr., Arnold AFS, TN
"Wind Tunnels and Testing Techniques," pp 21-1 - 21-19 (Feb 1984) (AD-A143 674) AD-P003 774

KEY WORDS: Turbine engines, Wind tunnel testing, Test facilities

Turbine engine testing in ground test facilities cannot rely upon the simulation parameters that are common to aerodynamic testing in wind tunnels. The interfaces between the internal fluid dynamics of the engine and the external aerodynamics of the flight vehicle are sometimes simulated in wind tunnels and sometimes duplicated in engine test facilities.

85-1478
Nondestructive Testing: Acoustic Holography. 1975 - September 1984 (Citations from the INSPEC: Information Services for the Physics and Engineering Communities Data Base)
NTIS, Springfield, VA
209 pp (Sept 1984) PB84-875525

KEY WORDS: Nondestructive tests, Acoustic holography, Bibliography

This bibliography contains citations concerning the applications of acoustic holography to nondestructive testing. Topics include stress measurement, imaging methods, defect characterization, crack detection and size measurement, weld defect identification, and computer assisted analysis of holograms. Modern acoustical holography test methods in nuclear reactor technology are also discussed.

SCALING AND MODELING

85-1479
Dynamic Stress Wave Reflections/Attenuation: Earthquake Simulation in Centrifuge Soil Models
C.J. Coe, J.H. Prevost, R.H. Scanlan
Princeton Univ., Princeton, NJ 08544
Earthquake Engrg. Struc. Dynam., 13 (1), pp 109-128 (Jan/Feb 1985) 17 figs, 2 tables, 11 refs

KEY WORDS: Earthquakes, Simulation

In this investigation, the feasibility of earthquake simulation in centrifuge soil experiments is studied. The strong detrimental effect of standing waves for such an endevour is clearly shown. A modest degree of success toward producing a model earthquake is reported via two devices -- a certain kind of physically tuned internal excitor and an effective absorbent material at the walls.

DIAGNOSTICS

85-1480
Vibration Analysis of a Large Industrial Fan
R.J. Sayer
Pickands Mather & Co., Cleveland, OH
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 634-644, 7 figs, 5 refs

KEY WORDS: Experimental modal analysis, Diagnostic techniques, Fans

This paper presents a case history of the vibration problems encountered by a series of large industrial fans. They are used to recirculate air in a traveling grate iron ore drying furnace in northern Minnesota. The motor frame and foundation had been experiencing vibration levels exceeding recommended allowable values, resulting in the premature failure of bearings and requiring numerous unscheduled maintenance shutdowns for balancing and cleaning equipment. Diagnostic field testing was performed to identify the problem and analytical analyses, including finite element representations, were prepared to evaluate different modification proposals. The fans were modified and vibration problems solved.

85-1481
Rotor Parameter Telemetering System
J.M. Bourgeois, F. Lalonde
Institut de recherche d'Hydro-Quebec (IREC) 1800 Montee Ste. Julie Varennes, Quebec, J0L 2P0
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 511-514, 5 figs, 3 refs

KEY WORDS: Modal analysis, Diagnostic techniques, Rotors, Power generators (electric), Slip rings

Hydro-Quebec's involvement in hydrogenerator diagnosis has led to the development of a transmission system for rotating information. This paper presents a telemetering system which uses the generator slip rings as the data transmission link. For this purpose, a high-frequency signal is superimposed on the slip rings which transmit the DC supply generating the magnetic field on the poles of the rotor.

BALANCING

85-1482
Modal Balancing of Flexible Shafts without Trial Weights
P.C. Morton
GEC Engrg. Res. Ctr., Lichfield Rd., Stafford, UK
IMechE, pp 71-78 (1985), 2 figs, 2 tables, 9 refs

KEY WORDS: Modal balancing technique, Flexible shafts

Most balancing procedures for flexible shafts involve the use of trial weights. The few techniques purporting to predict the shaft unbalance mathematically rely on modelling the system from measured characteristics. The bearings are difficult to model and the technique presented in the present paper evades the necessity for doing this. A technique is presented whereby the unbalance on a rotating shaft can be directly calculated from running vibration; no explicit representation of the bearing characteristics is required.

MONITORING

85-1483
The FFT Analyzer Its Application to Paper Industry
M. Barasch
Mechanical Technology Inc., 968 Albany-Shaker Rd., Latham, NY 12110
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. I, pp 346-359, 10 figs, 19 refs

KEY WORDS: Fast fourier transform, Spectrum analyzers, Monitoring techniques, Paper products, Industrial facilities

The spectrum analysis was used for describing periodic phenomena for a long time. The spectrum analysis technique is becoming a common procedure in diagnosing pending troubles in rotating parts of the paper machine. The same technique is used in interpreting pulsating phenomena occurring at the wet end of the paper machine. This article is intended to help the reader to understand the drawbacks of the Fast Fourier Analysis rather than presenting its multiple benefits.

ANALYSIS AND DESIGN

ANALYTICAL METHODS

85-1484

Applicability of the Biot Theory. I. Low-Porosity Materials

P.R. Ogushwitz
Bell Telephone Labs., Inc., Whippany, NJ 07981

J. Acoust. Soc. Amer., 77 (2), pp 429-440 (Feb 1985), 10 figs, 4 tables, 47 refs

KEY WORDS: Wave propagation, Porous materials, Composite materials, Biot theory, Underwater sound

The Biot theory of wave propagation in porous, saturated materials contains 13 parameters. Empirical and theoretical ways to predict values of these parameters for natural material are discussed. The self-consistent theory of composites is used to predict the elastic moduli of the skeletal frame assuming that the inclusions (pore fluid, sediment grains) are needle-shaped at low concentrations. The Biot theory is then used to predict compressional and shear wave speeds in consolidated materials. In a man-made material (porous sintered glass), the predictions agree with experimental data to within 3%.

85-1485

Applicability of the Biot Theory. II. Suspensions

P.R. Ogushwitz
Bell Telephone Labs., Inc., Whippany, NJ 07981

J. Acoust. Soc. Amer., 77 (2), pp 441-452 (Feb 1985), 16 figs, 3 tables, 30 refs

KEY WORDS: Wave propagation, Liquids, Biot theory, Underwater sound,

The Biot theory is used to compute compressional wave speeds and attenuation in fluid-solid suspensions. The frame moduli are estimated from the self-consistent theory of composites, assuming needle-shaped pores and spherical or ellipsoidal grains of uniform size. The permeability is computed from the Kozeny-Carman equation. The attenuation data are matched by assuming that all losses are caused by viscous absorption in the fluid. For suspensions of kaolinite, polystyrene beads, and glass beads in various fluids, the Biot model agrees with experimental sound speed data at least as well as do other models. For aqueous suspensions of kaolinite, of attapulgite, and of hydrous aluminum silicate pigments, the Biot model generally is in better agreement with attenuation data than are other models.

85-1486

Applicability of the Biot Theory. III. Wave Speeds Versus Depth in Marine Sediments

P.R. Ogushwitz
Bell Telephone Labs., Inc., Whippany, NJ 07981

J. Acoust. Soc. Amer., 77 (2), pp 453-464 (Feb 1985), 18 figs, 2 tables, 27 refs

KEY WORDS: Wave propagation, Underwater sound, Biot theory

Empirical and theoretical methods are used to estimate the elastic moduli of the skeletal frame in sedimentary materials. The Biot model is then used to estimate compressional wave speeds as a function of depth. These estimates are compared to laboratory data and to field measurements. Using the empirical method to estimate the frame moduli, the measured wave speeds

are matched within 3% for Ottawa sand pack and within 10% for glass bead pack at pressures corresponding to depths of about 500 m or less. A new method for estimating the frame moduli of partially consolidated materials is used to quantify the effects of grain packing and cementation. Velocity gradients are estimated for shear and compressional waves in terrigenous sand and calcareous clay.

85-1487

Application of Iteration Perturbation Method to Coupling Eigenvalue Problems

T. Aizawa
Univ. of Tokyo, 3-8-1 Komaba, Meguro-ku, Tokyo 153, Japan

Bull. JSME, 28 (235), pp 132-138 (Jan 1985), 4 figs, 3 tables, 8 refs

KEY WORDS: Eigenvalue problems, Perturbation theory, Iteration, Fluid-induced excitation

The flow-induced vibrations often cause severe troubles in nuclear reactor components, and hence mechanical engineers must make coupling eigenvalue analyses taking into account some interactions between structures and fluids. In this type of problems, natural frequencies and their associated modes should be calculated with sufficient accuracy, and for such purposes finite element method is usually a convenient tool. However, since conventional methods increases computer costs, more efficient algorithms are necessary for practical design analyses. In this paper an iteration perturbation method to treat such eigenvalue problems is proposed.

85-1488

The Discretization Error of Newmark's Method for Numerical Integration in Structural Dynamics

J.M.B. Brown
Univ. of Dundee, Scotland

Earthquake Engrg. Struc. Dynam., 13 (1), pp 43-51 (Jan/Feb 1985) 4 figs, 8 refs

KEY WORDS: Integration methods, Newmark method, Time dependent parameters, Damping effects

The usual assessment of performance of Newmark's method for direct integration in structural dynamics is by reference to amplitude and period error of a single mode of vibration. As an alternative the local and global truncation errors due to the time discretization are introduced. Methods of obtaining norms of the error sequences are presented. The results of numerical experiments confirm the anticipated error order and show how the error formula varies with Beta. The effect of the presence of physical damping on the error order and formula is also examined.

85-1489

Structural Design Sensitivity Analysis with General Boundary Conditions: Dynamic Problem

C.C. Hsieh, J.S. Arora
Univ. of Iowa, Iowa City, IA

Intl. J. Numer. Methods Engrg. 21 (2), pp 267-283 (Feb 1985) 4 figs, 4 tables, 10 refs

KEY WORDS: Eigenvalue problems, Design sensitivity analysis

This paper presents methods for design sensitivity analysis of dynamic response of structural systems when general boundary conditions are imposed during the analysis phase. Eigenvalue as well as transient response problems are discussed.

85-1490

Modal Coordinates in the Calculation of Finite Element Dynamics (Modale Koordinaten in der Finite-Elemente-Dynamikrechnung)

M. Weck, E. Prossler, H. Helpenstein
Lehrstuhl f. Werkzeugmaschinen, Laboratorium f. Werkzeugmaschinen und Betriebslehre, Rheinisch-Westfalische Technische Hochschule Aachen, W. Germany

VDI-Z., 126 (23/24), pp 919-927 (Dec 1984) 20 figs, 7 refs (In German)

KEY WORDS: Finite element technique, Modal coordinates

Calculation of the dynamic behavior of elasto-mechanical structures usually in-

volves high expenditures, so that the calculation of variants must be restricted to only few modifications. In this respect the calculation in modal coordinates seems to offer some advantages. The subject of "modal coordinates in the calculation of element dynamics" requires, to start with, explanation as to the origin and meaning of modal coordinates. Then in this contribution the calculation of dynamic deformation is treated with the aid of modal coordinates and the efficiency of this method is made clear. The computation times required are discussed as well as the quality of results illustrated by examples. By the calculation of substructures in modal coordinates a novel method is presented for the calculation of variants. The contribution is concluded by outlining future aspects with respect to further developments.

85-1491

Numerical Bounding Methods for the Eigenvalues of Elastic Structures (Sur les méthodes de calcul par encadrement des fréquences propres des structures élastiques)

P. Ladeveze, J.P. Pelle
Laboratoire de Mecanique et Technologie, E.N.S.E.T./Universite Paris -VI/C.N.R.S., 61, avenue du President Wilson, 94230 Cachan, France
J. de Mecanique Theor. Appl., 3 (5), pp 689-715 (1984) 4 tables, 12 refs (In French)

KEY WORDS: Eigenvalue problems, Natural frequencies

Two methods for bounding natural frequencies are proposed. The first one is based on the classical kinematic formulation associated with the Rayleigh's quotient. The second one is based on a "static" formulation which seems to be of great interest to numerical calculations. These methods are tested on the problem of a clamped elastic membrane.

85-1492

Spectral Methods for the Euler Equations: Part II - Chebyshev Methods and Shock Fitting

M.Y. Hussaini, D.A. Kopriva, M.D. Salas, T.A. Zang
NASA Langley Res. Ctr., Hampton, VA
AIAA J., 23 (2), pp 234-240 (Feb 1985) 8 figs, 12 refs

KEY WORDS: Spectral analysis, Euler equation

The Chebyshev spectral collocation method for the Euler gasdynamic equations is described. It is used with shock fitting to compute several two-dimensional gasdynamic flows. Examples include a shock/acoustic wave interaction, a shock/vortex interaction, and the classical blunt-body problem. With shock fitting, the spectral method has a clear advantage over second-order finite differences in that equivalent accuracy can be obtained with far fewer grid points.

DESIGN TECHNIQUES

85-1493

Structural Dynamics Modification Using Generalized Beam Mass and Stiffness Matrices

J.C. O'Callahan, Chaur-Ming Chou
University of Lowell, Lowell, MA
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. I, pp 477-482, 5 figs, 2 tables, 10 refs

KEY WORDS: Modal analysis, Structural modification techniques, Rotational degrees of freedom, Mass matrices, Stiffness matrices

The mass and stiffness matrices of a generalized beam element are implemented in a modification procedure which can be used to efficiently modify the dynamic characteristics of a structural system. In order to perform the modification, a modal data base of the original system is needed which can be obtained from either a finite element model or an experimental modal survey. This process requires the inclusion of rotational degrees of freedom since a

full beam modification implies moment transfer and attachment offset effects.

COMPUTER PROGRAMS

85-1494
NASTRAN Forced Vibration Analysis of Rotating Cyclic Structures
V. Elchuri, G.C.C. Smith, A.M. Gallo
Bell Aerospace Textron, Buffalo, NY
Rept. No. NASA-CR-173821, 31 pp (1983)
N84-29252

KEY WORDS: Computer programs, Rotating structures, Forced vibration

Theoretical aspects of a new capability developed and implemented in NASTRAN level 17.7 to analyze forced vibration of a cyclic structure rotating about its axis of symmetry are presented. Fans, propellers, and bladed shrouded discs of turbomachines are some examples of such structures. The capability includes the effects of Coriolis and centripetal accelerations on the rotating structure which can be loaded with directly applied loads moving with the structure and inertial loads due to the translational acceleration of the axis of rotation ('base' acceleration).

85-1495
SPAR Improved Structure-Fluid Dynamic Analysis Capability, Phase 2
M.L. Pearson
Softcom Systems, Inc., Huntsville, AL
Rept. No. LMSC-HREC-TR-D951490, NASA-CR-171078, 75 pp (June 29, 1984)
N84-29153

KEY WORDS: Fluid-structure interaction, Computer programs

An efficient and general method of analyzing a coupled dynamic system of fluid flow and elastic structures is investigated. The improvement of Structural Performance Analysis and Redesign (SPAR) code is summarized. All error codes are documented and the SPAR processor/subroutine cross reference is included.

GENERAL TOPICS

USEFUL APPLICATIONS

85-1496
Vibratory Compaction of Powder Metal and Refractory Materials. 1966 -September, 1984 (Citations from the Metals Abstracts Data Base)
NTIS, Springfield, VA
99 pp (Sept 1984) PB84-875806

KEY WORDS: Compacting, Vibratory techniques, Metals, Bibliographies

This bibliography contains citations concerning the techniques and equipment for the vibratory compaction of refractory materials and powder metals. Emphasis is placed on ultrasonic compaction, and the manufacture of powder metallurgical parts as well as refractory metal carbides. The compaction of nuclear fuel elements using uranium oxide powders is included.

AUTHOR INDEX

CALENDAR

1985

AUGUST

4-8 **International Computers in Engineering Conference and Exhibition** [ASME] Boston, MA (ASME)

5-10 **SAE West Coast International Meeting** [SAE] Portland, OR (SAE)

SEPTEMBER

2-7 **International Gas Turbine Symposium and Exposition** [Gas Turbine Div., ASME; Chinese Natl. Aero-Technology Import and Export Corp.; Chinese Soc. of Aeronautics and Astronautics] Beijing, People's Rep. China (Intl. Gas Turbine Ctr., 4250 Perimeter Park South, Suite 108, Atlanta, GA 30341 -(404) 451-1905)

9-11 **19th Midwestern Mechanics Conference** [Ohio State Univ.] Columbus, OH (Dept. of Engrg. Mech., Ohio State Univ., 155 W. Woodruff Ave., Columbus, OH 43210 - (614) 422-2731)

10-13 **Design Automation Conference** [ASME] Cincinnati, OH (ASME)

10-13 **Failure Prevention and Reliability Conference** [ASME] Cincinnati, OH (ASME)

10-13 **Vibrations Conference** [ASME] Cincinnati, OH (ASME)

15-17 **Petroleum Workshop and Conference** [ASME] Kansas City, MO (ASME)

16-20 **DIAGNOSTICS - 85** [Technical Univ. Poznan / Polish Academy Sciences] Leszno, Poland (Diagnostics -85, Prof. C. Cempel, Tech. Univ. Poznan, Piotrowo 3, P.O. Box 5, 60-695 Poznan, Poland)

17-19 **Mathematics in Signal Processing**, Bath, UK (Institute of Mathematics, Maitland House, Warrior Square, Southend-on-Sea, Essex SS1 2JY, UK)

18-20 **INTER-NOISE '85** [Intl. Inst. Noise Control Engrg.] Munich, Fed. Rep. Germany (E. Zwicker, Institut f. Elektroakustik, TU Munchen, Arcisstr. 21, 8000 Munchen 2, Fed. Rep. Germany)

23-25 **International Congress on Acoustic Intensity**, Senlis, France (M. Bockoff, CETIM, B.P. 67, 60304 Senlis, France)

24-27 **Conference on Noise Control '85**, Krakow, Poland (Institute of Mechanics and Vibroacoustics AGH, ul. Mickiewicza 30, 30-059 Krakow, Poland)

OCTOBER

2-4 **International Acoustics Symposium**, Pretoria, South Africa (Symposium Secretariat IRS, CSIR, P.O. Box 395, Pretoria 0001, South Africa)

6-8 **Diesel and Gas Engine Power Technical Conference** [ASME] West Middlesex, PA (ASME)

8-10 **Lubrication Conference** [ASLE/-ASME] Atlanta, GA (ASLE/ASME)

8-11 **Stapp Car Crash Conference** [SAE] Arlington, VA (SAE)

14-17 **Aerospace Congress and Exposition** [SAE] Los Angeles, CA (SAE)

20-24 **Power Generation Conference** [ASME] Milwaukee, WI (ASME)

22-24 **14th Turbomachinery Symposium** [Turbomachinery Labs.] Houston, TX (Dara Childs, Turbomachinery Labs., Dept. of Mech. Engrg., Texas A&M Univ., College Station, TX 77843)

22-24 **56th Shock and Vibration Symposium** [Shock and Vibration Information Ctr., Washington, D.C.] Monterey, CA (Dr. J. Gordan Showalter, Acting Director, SVIC, Naval Res. Lab., Code 5804, Washington, D.C. 20375-5000 - (202) 767-2220)

NOVEMBER

4-8 Acoustical Society of America, Fall Meeting [ASA] Nashville, TN (ASA)

11-14 Truck and Bus Meeting and Exposition [SAE] South Bend, IN (SAE)

17-22 American Society of Mechanical Engineers, Winter Annual Meeting [ASME] Miami Beach, FL (ASME)

24-26 Australian Acoustical Society Annual Conference, Leura, Australia (A. Lawrence, Graduate School, University of N.S.W., Box 1, Kensington, N.S.W. 2033, Australia)

DECEMBER

11-13 Western Design Engineering Show [ASME] Anaheim, CA (ASME)

1986

JANUARY

28-30 Reliability and Maintainability Symposium [ASME] Las Vegas, NV (ASME)

MARCH

5-7 Vibration Damping Workshop II [Flight Dynamics Laboratory of the Air Force Wright Aeronautical Labs.] Las Vegas, NV (Mrs. Melissa Arrajj, Administrative Chairman, Martin Marietta Denver Aerospace, P.O. Box 179, Mail Stop M0486, Denver, CO 80201 - (303) 977-8721)

24-27 Design Engineering Conference and Show [ASME] Chicago, IL (ASME)

APRIL

8-11 International Conference on Acoustics, Speech, and Signal Processing [Acoustical Society of Japan, IEEE ASSP Society, and Institute of Electronics and Communication Engineers of Japan] Tokyo, Japan (Hiroya Fujisaki, EE Department, Faculty of Engineering, University of Tokyo, Bunkyo-ku, Tokyo 113, Japan)

13-16 American Power Conference [ASME] Chicago, IL (ASME)

29-1 9th International Symposium on Ballistics [Royal Armament Research and Development Establishment] RMCS, Shrivenham, Wiltshire, UK (Mr. N. Griffiths, OBE, Head/XT Group, RARDE, Fort Halstead, Sevenoaks, Kent TN14 7BP, England)

MAY

12-16 Acoustical Society of America, Spring Meeting [ASA] Cleveland, OH (ASA Hqs.)

JUNE

3-6 Symposium and Exhibit on Noise Control [Hungarian Optical, Acoustical, and Cinematographic Society; National Environmental Protection Authority of Hungary] Szeged, Hungary (Mrs. Ildiko Baba, OPAKFI, Anker koz 1, 1061 Budapest, Hungary)

JULY

20-24 International Computers in Engineering Conference and Exhibition [ASME] Chicago, IL (ASME)

21-23 INTER-NOISE 86 [Institute of Noise Control Engineering] Cambridge, MA (Professor Richard H. Lyon, Chairman, INTER-NOISE 86, INTER-NOISE 86 Secretariat, MIT Special Events Office, Room 7-111, Cambridge, MA 02139)

24-31 12th International Congress on Acoustics, Toronto, Canada (12th ICA Secretariat, P.O. Box 123, Station Q, Toronto, Ontario, Canada M4T 2L7)

SEPTEMBER

14-17 International Conference on Rotordynamics [IFToMM and Japan Society of Mechanical Engineers] Tokyo, Japan (Japan Society of Mechanical Engineers, Sanshin Hokusei Bldg., 4-9, Yoyogi 2-chome, Shibuyak-ku, Tokyo, Japan)

OCTOBER

5–8 Design Automation Conference [ASME] Columbus, OH (ASME)

5–8 Mechanisms Conference [ASME] Columbus, OH (ASME)

19–23 Power Generation Conference [ASME] Portland, OR (ASME)

20–22 Lubrication Conference [ASME] Pittsburgh, PA (ASME)

NOVEMBER

30–5 American Society of Mechanical Engineers, Winter Annual Meeting [ASME] San Francisco, CA (ASME)

CALENDAR ACRONYM DEFINITIONS AND ADDRESSES OF SOCIETY HEADQUARTERS

AHS American Helicopter Society
1325 18 St. N.W.
Washington, D.C. 20036

AIAA American Institute of Aeronautics and Astronautics
1633 Broadway
New York, NY 10019

ASA Acoustical Society of America
335 E. 45th St.
New York, NY 10017

ASCE American Society of Civil Engineers
United Engineering Center
345 E. 47th St.
New York, NY 10017

ASLE American Society of Lubrication Engineers
838 Busse Highway
Park Ridge, IL 60068

ASME American Society of Mechanical Engineers
United Engineering Center
345 E. 47th St.
New York, NY 10017

ASTM American Society for Testing and Materials
1916 Race St.
Philadelphia, PA 19103

ICF International Congress on Fracture
Tohoku University
Sendai, Japan

IEEE Institute of Electrical and Electronics Engineers
United Engineering Center
345 E. 47th St.
New York, NY 10017

IES Institute of Environmental Sciences
940 E. Northwest Highway
Mt. Prospect, IL 60056

IMechE Institution of Mechanical Engineers
1 Birdcage Walk, Westminster
London SW1, UK

IFToMM International Federation for Theory of Machines and Mechanisms
U.S. Council for TMM
c/o Univ. Mass., Dept. ME
Amherst, MA 01002

INCE Institute of Noise Control Engineering
P.O. Box 3206, Arlington Branch
Poughkeepsie, NY 12603

ISA Instrument Society of America
67 Alexander Dr.
Research Triangle Pk., NC 27709

SAE Society of Automotive Engineers
400 Commonwealth Dr.
Warrendale, PA 15096

SEE Society of Environmental Engineers
Owles Hall, Buntingford, Hertz.
SG9 9PL, England

SESA Society for Experimental Mechanics (formerly Society for Experimental Stress Analysis)
14 Fairfield Dr.
Brookfield Center, CT 06805

SNAME Society of Naval Architects and Marine Engineers
74 Trinity Pl.
New York, NY 10006

SPE Society of Petroleum Engineers
6200 N. Central Expressway
Dallas, TX 75206

SVIC Shock and Vibration Information Center
Naval Research Laboratory
Code 5804
Washington, D.C. 20375-5000

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PUBLICATION POLICY

Unsolicited articles are accepted for publication in the *Shock and Vibration Digest*. Feature articles should be tutorials and/or reviews of areas of interest to shock and vibration engineers. Literature review articles should provide a subjective critique/summary of papers, patents, proceedings, and reports of a pertinent topic in the shock and vibration field. A literature review should stress important recent technology. Only pertinent literature should be cited. Illustrations are encouraged. Detailed mathematical derivations are discouraged; rather, simple formulas representing results should be used. When complex formulas cannot be avoided, a functional form should be used so that readers will understand the interaction between parameters and variables.

Manuscripts must be typed (double-spaced) and figures attached. It is strongly recommended that line figures be rendered in ink or heavy pencil and neatly labeled. Photographs must be unscreened glossy black and white prints. The format for references shown in Digest articles is to be followed.

Manuscripts must begin with a brief abstract, or summary. Only material referred to in the text should be included in the list of References at the end of the article. References should be cited in text by consecutive numbers in brackets, as in the following example:

> Unfortunately, such information is often unreliable, particularly statistical data pertinent to a reliability assessment, as has been previously noted [1].
>
> Critical and certain related excitations were first applied to the problem of assessing system reliability almost a decade ago [2]. Since then, the variations that have been developed and practical applications that have been explored [3-7] indicate . . .

The format and style for the list of References at the end of the article are as follows:

- each citation number as it appears in text (not in alphabetical order)
- last name of author/editor followed by initials or first name
- titles of articles within quotations, titles of books underlined
- abbreviated title of journal in which article was published (see Periodicals Scanned list in January, June, and December issues)
- volume, issue number, and pages for journals; publisher for books
- year of publication in parentheses

A sample reference list is given below.

1. Platzer, M.F., "Transonic Blade Flutter — A Survey," Shock Vib. Dig., 7 (7), pp 97-106 (July 1975).
2. Bisplinghoff, R.L., Ashley, H., and Halfman, R.L., Aeroelasticity, Addison-Wesley (1955).
3. Jones, W.P., (Ed.), "Manual on Aeroelasticity," Part II, Aerodynamic Aspects, Advisory Group Aeronaut. Res. Dev. (1962).

Articles for the Digest will be reviewed for technical content and edited for style and format. Before an article is submitted, the topic area should be cleared with the editors of the Digest. Literature review topics are assigned on a first come basis. Topics should be narrow and well-defined. Articles should be 3000 to 4000 words in length. For additional information on topics and editorial policies, please contact:

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THE SHOCK AND VIBRATION DIGEST

July 1985

Volume 17, No. 7

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